



# CITY OF CAMARILLO

**DEPARTMENT OF PLANNING AND COMMUNITY DEVELOPMENT**  
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## MEMORANDUM

**DATE:** NOVEMBER 8, 2000

**TO:** HEAD LIBRARIAN

**FROM:** PLANNING AND COMMUNITY DEVELOPMENT

**SUBJECT: SAFETY ELEMENT OF THE GENERAL PLAN**

ENCLOSED IS THE SAFETY ELEMENT OF THE CITY OF CAMARILLO GENERAL PLAN. THIS ELEMENT WAS UPDATED THIS YEAR, SO WE HAVE ENCLOSED THAT VERSION. THE HOUSING ELEMENT IS IN THE PROCESS OF BEING UPDATED AT THIS TIME. WHEN THAT IS COMPLETE, WE WILL FORWARD A COPY TO YOU AT THAT TIME.

THANK YOU.

:LL (D:\WF\MEMO-GENPLAN BERKELEY)

ATTACHMENT



# SAFETY ELEMENT

INSTITUTE OF GOVERNMENT  
STUDIES LIBRARY  
NOV 13 2000



PLANNING DEPARTMENT  
CITY OF CAMARILLO  
601 CARMEN DRIVE  
CAMARILLO CA 93010

## INTRODUCTION

UNIVERSITY OF CALIFORNIA

## BACKGROUND

The California Government Code requires the preparation of a Safety Element for the protection of the community from any unreasonable risks associated with the effects of seismically induced ground rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; subsidence and other known geologic hazards; flooding; and wild-land and urban fires. The Safety Element shall also include mapping of known seismic and other geologic hazards. It shall also address evacuation routes, peak-load water supply requirements, and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards.

The State of California in 1984 consolidated the seismic safety requirements with those of the safety element and deleted the requirement for the adoption of a separate safety element. Historically, the safety and seismic safety elements joined the state statutes in 1971 in response to the wildfires in October and November, 1970, and the San Fernando earthquake in February 1971.

The aim of the Safety Element is to reduce death, injuries, property damage, and the economic and social dislocation resulting from natural hazards including: flooding; mudslides and soil creep; tsunamis and seiches; land subsidence; earthquakes; avalanches; other geologic phenomena; levee or dam failure; certain types of urban and wildland fires; and building collapse.

The Safety Element is the primary vehicle for identifying hazards in making land use decisions. While the Safety Element focuses on identifying fire and geologic hazards, it also may address impacts associated with the storage and disposal of hazardous materials.

## PURPOSE

In preparing the Safety Element, a number of purposes will hopefully be achieved. Among these are:

1. To meet the requirements of the State Law.
2. To investigate the various hazards from a regional as well as a local perspective so as to provide a more integrated picture of the hazardous conditions within Ventura County and the City of Camarillo.
3. To develop a framework which will permit the investigation of all types of hazards and the resources they impact.
4. To present the information collected in a form which will allow decision makers and the public to quickly evaluate the pertinent aspects of a given hazard.

5. To offer a range of response measures from which decision makers may choose as they attempt to alleviate a given hazard.
6. To provide a framework in which future inventory and analysis can be performed.

## **HAZARD EVALUATION**

One of the purposes of the Safety Element is to provide decision makers with the information necessary to evaluate the nature of a given hazard and possible courses of action. To facilitate this, it is felt that decision makers and the general public should have a general knowledge of a hazard, know where it exists and who is managing it. In addition, one should know the probability of the hazard occurring, the severity of the hazard should it occur, and the validity of the information which leads to conclusions in the above area.

One aspect not addressed in the document, but which will automatically enter into any final decision relative to hazards, is the cost involved. This matter was not addressed because only the local jurisdiction can place values on resources that may be lost; and only the local jurisdiction can decide on the appropriate response to a hazard and its attendant costs. A local entity's conclusion about costs and benefits are then the final elements in a Risk Analysis, which evaluates: probability, severity, resources, the validity of information and cost benefits. This has been done for Camarillo in the public hearings that preceded adoption of the Element of the General Plan, and are shown in the POLICIES that conclude each discussion.

A number of maps accompany each hazard discussed. These maps are an essential part of any hazard evaluation. Hazard zones appear on these maps which depict varying degrees of severity for a given hazard. While these zones are, by necessity, defined by distinct lines, the hazard depicted may not conform exactly to the defined zones. The reasons for this are imprecise data, and small scale maps that do not permit the detailed plotting of data.

## **FAULT DISPLACEMENT**

### **GENERAL DISCUSSION**

Surface Faulting (D.R. Nichols, U. S. Geological Survey)

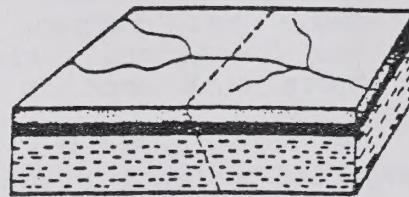
The earth is laced with faults - surfaces (planar or irregular) in earth materials along which failure has occurred and materials on opposite sides have moved relative to one another in response to the accumulation of stress. Most of these faults have not moved for hundreds of thousands or even millions of years and thus can be considered inactive. Others, however, show evidence of current activity or have moved sufficiently recently to be considered active (i.e., capable of displacement in the near future). Any fault movement beneath a building in excess of an inch or two could have catastrophic effects on the structure, depending upon its design and construction, and the shaking stresses it experiences at the same

time. Therefore, knowing not only which faults may move, but how they might move is important.

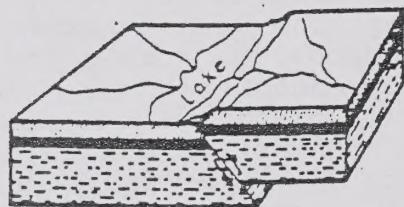
The definition of what constitutes an "active fault" may vary greatly according to the type of land use contemplated or to the importance of the structure. For example, the Atomic Energy Commission regards a fault as active or "capable" with respect to nuclear reactor sites if it has moved "at or near the ground surface at least once in the past 35,000 years;" or "more than once in the past 500,000 years" (Atomic Energy Commission, 1971).

Commonly, faults are regarded as active and of concern to land use planning when there is evidence that they have moved during historical time or, through geologic evidence, there may be a significant likelihood that they will move during the projected use of a particular structure or piece of land. Because geologic evidence may be lacking, obscure, or ambiguous as to specific times of past movement, geologists may be able to estimate relative degree of activity only after a regional analysis that may extend far beyond the locality under consideration. Such analysis may be based on historical evidence of fault movement, seismic activity (occurrence of small to moderate earthquakes along the fault movement), displacement of recent earth layers (those deposited during the past 11,000 years), and the presence of topographically young fault-produced features (scarp, sag ponds, offset stream courses and disruption of man-made features such as fences, curbs, etc.). Movement, however seldom, can be limited to a single fault surface (or zone) throughout the lifetime of a fault system. Faults that commonly produce significant displacement (more than several inches at a time) often have related branches that diverge from the main fault, but usually have less movement along them. Main faults also may have secondary faults that are not directly or obviously connected physically to the main fault trace.

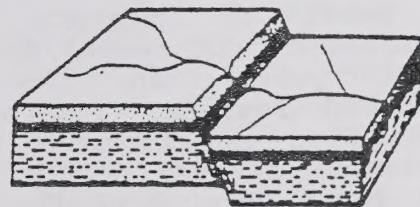
ILLUSTRATION 1, EXAMPLES OF FAULT DISPLACEMENT



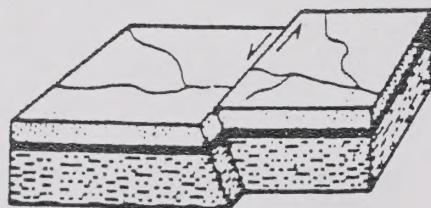
Earth block before movement



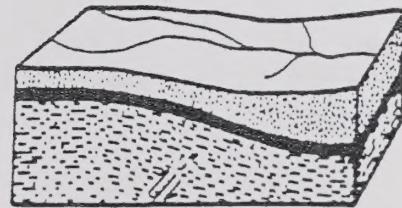
1a. Thrust or reverse fault



1b. Normal fault



1c. Left lateral fault



1d. Monoclinic fold caused by faulting at depth

Source: Tri-Counties Seismic Safety Study,  
1973, pg. 68

Secondary faults are usually nearby (within hundreds of feet of the main rupture), but they may extend as much as several miles away. As with branch faults, displacement along secondary faults is usually only a fraction of that along a main fault.

For planning purposes there are two kinds of faults: (1) active faults which have experienced displacement in recent geologic time, suggesting that future displacement can be expected on these faults; and (2) inactive faults that have shown no evidence of movement in recent geologic time, suggesting that those faults are dormant. However, some faults labeled as inactive are so termed due to lack of knowledge. Increased research and monitoring of those faults could reveal some of them as active.

The State Division of Mines and Geology ("Urban Geology," 1973, Bull. 199) indicates that on a State-wide basis, the potential hazard to structures from the surface displacement of faults is low compared to such geologic phenomena as earthquake shaking and landsliding. Historically, major losses due to fault displacement have been limited to the San Fernando Earthquake of 1971. Structural losses due to fault displacement in the 26 other major earthquakes in California are unknown, but were probably small. Most of the losses incurred during the 1906 San Francisco Earthquake and 1952 Tehachapi Earthquake were caused by earthquake shaking and the ensuing fires.

## GENERAL EFFECTS OF THE POTENTIAL HAZARD

### PRIMARY EFFECTS

Nearly all manmade structures are susceptible to damage ranging from severe to total when affected by displacement along faults passing beneath their foundations. The San Fernando Earthquake of 1971 has shown that structures designed under present standards are not safe from severe damage or destruction as a result of surface fault displacement of foundations. The design of most structures, such as single-family homes or larger structures, roads, bridges, pipelines, or other conduits, to resist fault displacement is generally not economically feasible. Only massive earth structures such as earthfill dams can be economically designed to remain functional after several feet of displacement along an underlying fault.

Permanent effects of surface displacements along faults also can include:

1. Abrupt elevation or depression of ground surfaces of several feet for distances of many hundreds of feet along the fault.
2. Disruption of surface drainage.
3. Changes in groundwater levels in wells.
4. Blockage and surface seepage of groundwater flow.
5. Changes in survey benchmark elevations.
6. Dislocation of street alignments and property lines of many feet, if lateral (horizontal) displacement also occurs along a

fault, etc.

## 7. Displacement of drainage channels and drains.

### SECONDARY EFFECTS

Secondary effects of surface displacements along faults within an urban area could include:

1. Disruption of travel along roadways due to abrupt depressions of elevation of pavement surfaces.
2. Possible flooding due to disruption of drainage channel and storm drain flow.
3. Disruption of utility services such as water, gas, fuel, telephone, and electric power lines. Disruption of fuel or gas lines poses fire hazards, whereas of water line breakage disrupts fire-fighting capabilities.
4. Temporary impact on industry and commerce similar to that resulting from the occurrence of most kinds of regional natural catastrophic events such as hurricanes or floods.

### GENERAL INVENTORY OF THE POTENTIAL HAZARD

#### LOCATION & HISTORY

Several significant active faults cross Ventura County. Regional assessments of seismic shaking potential have analyzed the hazard associated with those faults. They have provided us with much of our current knowledge about the faults that could potentially affect the Camarillo area. Although the 1971 San Fernando and 1994 Northridge earthquakes occurred outside of Ventura County (in the San Fernando Valley), they were caused by rupture along two major fault systems that continue westward into Ventura County. Those earthquakes dramatically illustrate the potential for damage that can be expected from future earthquakes in the Los Angeles, Ventura, and Santa Barbara areas.

Both the San Fernando and the Northridge earthquakes occurred on east-west-trending reverse faults, a fault type that is common throughout Ventura County and the City of Camarillo. On the basis of experiences from those earthquakes and similarities between their causative faults and the faults in Ventura County, the City of Camarillo probably will experience strong ground shaking that could last perhaps several tens of seconds, if one of the local Ventura County faults ruptures. If the local fault system present in the Camarillo area ruptures, there is a potential for the additional hazard of ground-surface rupture in the city.

In the 1990s, many geologic fault studies were performed throughout southern California, due in large part to growth and development in the region. The results of those studies have substantially increased geologic awareness of the seismic hazard potential in Ventura County. Studies by both the Southern California Earthquake Center (SCEC) and the California Division of Mines and Geology (CDMG)

have developed well-researched and peer-reviewed fault models on which most current estimates of seismic hazard are based. The following are descriptions of some of the major active faults and fault systems within Ventura County that might produce earthquakes that could have an impact on the city of Camarillo.

### **MALIBU/SANTA MONICA/RAYMOND FAULT SYSTEM**

This fault system is believed to consist of a series of major north-dipping thrust faults, which extend along the coast and onshore for a total of over 40 miles and perhaps a much greater distance offshore in the Santa Barbara Channel. It begins in the San Bernardino area and extends along the southern base of the Santa Monica Mountains and passes offshore a few miles west of Point Dume.

Geologic evidence for activity of the fault system during recent geologic time up through the present are fault terrace and near-surface sedimentary deposits, groundwater barriers and the Point Mugu Earthquake (February, 1973), which is believed to have originated on the Malibu Fault.

The faults within this system are considered active.

### **SIMI/SANTA ROSA FAULT**

The Simi/Santa Rosa fault zone is a complex zone of faults that trends westward from the Santa Susana Mountains, along the northerly margin of the Simi and Tierra Rejada Valleys, along the southern slopes of the Las Posas and Camarillo Hills, to their westerly termination at the western edge of Camarillo. The western termination of the fault zone is believed to occur at a northwest-trending near-vertical "tear fault" called the Wright Road fault. In the city of Camarillo, the Simi/Santa Rosa fault zone consists of three named faults; the Springville, Camarillo, and Santa Rosa Valley faults.

Although the major faults in the Simi/Santa Rosa fault zone are north-dipping reverse faults, the fault zone also includes south-dipping antithetic faults (minor normal faults that are of the opposite orientation to the major fault with which they are associated) that have developed primarily from drag folding near north-dipping reverse faults. In addition, the structure is further complicated by several south-dipping back-thrust faults that have been documented within the fault zone.

Although portions of the Simi/Santa Rosa fault zone were first mapped by Kew in 1919, the fault zone was shown more completely and named the Simi fault by Bailey (1951). Geologic maps prepared during the 1970s, 1980s, and 1990s further refined the style and location of the fault along portions of its trace (Weber et al., 1973 and 1976; Jakes, 1979; Hanson, 1981; Dibblee and Ehrenspeck, 1990; and Dibblee 1992). However, the fault was not recognized to be active until the late 1980s (Petra, 1989). Since its activity was first documented in 1989, several other geologic studies also have demonstrated recent faulting. The evidence for recent activity on the fault includes both geologic and geomorphic data.

Geologic data have been developed from trench exposures in Camarillo, Tierra Rejada Valley, and Simi Valley. In those exposures, soil or colluvium strata that are only a few thousand years old are cut by the fault, thereby demonstrating that the fault zone is active. On the basis of data obtained from trenching on the Spanish Hills development in western Camarillo, the fault may have a recurrence interval on the order of about 1,000 years with the most recent event having occurred about 900 ( $\pm$  a few hundred) years ago.

In the Camarillo area, geomorphic data indicative of recent fault activity include a warped Holocene alluvial surface along the Camarillo fault trace between Camarillo High School and the Southern Pacific Railroad tracks, abrupt breaks at the toes of slopes, and linear mountain fronts. Elsewhere along the fault zone, geomorphic evidence includes ponded and offset slopewash, possible side-hill benches that may indicate the presence of grabens, north-facing scarps on ridges, arcuate lineaments in alluvium that have been demonstrated to be coincident with shallow thrust faulting, the presence of a shallow bedrock sill that forms a groundwater barrier near the western end of Simi Valley, and left-lateral deflections of several stream channels.

No earthquake epicenters of moment magnitude 4.0 or greater have been recorded along the fault during historical time. A plot of seismicity from August 1983 to December 1993 (Treiman, 1998) shows very limited, low magnitude (less than M=4), epicenters near the Simi Santa Rosa fault zone during that time interval. Simila and Armand (1991) state that the zone is characterized by a very low level of activity. A more rigorous evaluation, considering hypocenter location and focal mechanisms would be necessary before attempting to draw any conclusions from the sparse seismicity data.

Since the implementation of the Alquist-Priolo Fault Hazard mapping program in 1973 (see definition on page 17), the State Division of Mines and Geology has established several Fault Hazard Zones along many of the major active faults within the State. Development proposed within those zones will require special geologic studies prior to approval to ensure that structures for human occupancy are not placed over a fault or fault branch. In 1998, portions of the Simi-Santa Rosa fault in the Camarillo quadrangle were designated as active faults under the Alquist-Priolo Act. In 1999, additional portions of the Simi-Santa Rosa fault system in the adjacent Newbury Park, Moorpark, Simi Valley West, and Simi Valley East quadrangles were also zoned.

The fault is considered active and poses both a surface-rupture potential and a potential seismic shaking hazard to the residents of the city of Camarillo.

### BAILEY FAULT

This fault marks the boundary between the western margin of the Santa Monica Mountains and the Oxnard Plain. It extends from the Mugu Lagoon area northerly to an apparent intersection with the Camarillo Fault near Calleguas Creek and State Highway 101. The presence of the fault is based primarily upon water well data.

No evidence of surface expression of the fault is known nor have any earthquakes been recorded as having originated on it. The fault trace is obscured by geologically young alluvium over its entire length. Available information is insufficient to conclude that the fault has not been active during Pleistocene or more recent time.

The fault is designated as potentially active until more information is available for evaluation.

### CAMARILLO FAULT

The Camarillo fault extends in an east-west direction from the southern side of Camarillo High School to the Camarillo Airport. The trace of the fault is highlighted by the abrupt linear ridges that have been uplifted along the northern side of the fault in the southern portion of Camarillo. Along the trend of the fault, a 10-foot-high step in the alluvial flood plain of Calleguas Creek parallels and underlies the Ventura freeway. The limited subsurface studies that have been performed along the Camarillo fault have exposed only subsidiary "bending moment" faults, which are considered to be secondary to the main structure (an inferred high-angle north-dipping reverse fault) that may not reach the surface.

Smith (1977), who found at that time that there was insufficient evidence to zone it under the State's Alquist-Priolo Act, evaluated the fault. However, after numerous geologic studies had been performed on faults throughout the city of Camarillo, Treiman (1997) determined that enough data had been obtained to justify zoning the fault as an active Alquist-Priolo Earthquake Fault Zone. Treiman (1997) recommended that, on the basis of its apparent Holocene age and probable surface rupture potential, the fault should be zoned.

The fault is considered active and poses both a surface-rupture potential and a seismic shaking potential to the residents of the city of Camarillo.

### WRIGHT ROAD FAULT

Whitney and Gath (1994) have postulated a tear fault at the western end of Camarillo. That fault was named the "Wright Road fault" after its most prominent scarp across Wright Road. There has been no subsurface work performed to specifically assess that structure. The trend of that postulated fault corresponds to the western end of the Camarillo anticline and the western end of South Mountain. Continued northwesterly projection of that feature corresponds to the eastern

end of the Ventura anticline at the relatively linear Aliso Canyon.

In 1998, CDMG zoned the Wright Road fault under the Alquist-Priolo Fault Hazard Zone Act after Treiman (1997) determined that it is an active, near-surface feature.

### SYCAMORE CANYON AND BONEY MOUNTAIN FAULTS

These faults are the most prominent of a series of northeast-trending breaks extending from the Point Mugu and south coast area to the Thousand Oaks area. The presence of the faults is evident by surface exposures showing displacement of sedimentary and volcanic rocks of pre-Pleistocene age.

Surface evidence of displacement of sedimentary and volcanic rocks or pre-Pleistocene age indicate that the faults have been active since deposition of those rocks. There is no evidence that they have displaced younger rocks. However, no specific investigations have been reported indicating that displacement of younger deposits has not occurred.

Possible aligned saddles and offset natural drainage channels along the northern side of the ridge south of Newbury Park may be suggestive of Quaternary activity along a branch of the Sycamore Canyon fault. However, no subsurface studies have been reported to evaluate the possibility that the fault is Holocene. Special areas of concern would be in the Potrero, Conejo, and Hidden Valleys, and the Thousand Oaks area.

The faults are designated as potentially active until more information is available for evaluation.





## OAK RIDGE FAULT SYSTEM

The Oak Ridge fault is a major 35- to 56-kilometer-long, south-dipping reverse fault. The fault extends from the Santa Susana Mountains, where it has been overridden by the north-dipping Santa Susana thrust fault, westward along the southerly side of the Santa Clara River Valley and then into the Oxnard Plain. The relationship of possible westerly extension of the fault to the McGrath and offshore faults is unclear and may be complex. Several workers (Yerkes and Lee, 1979; Ziony and Yerkes, 1985; Petersen et al., 1996) continue the Oak Ridge fault offshore into the Santa Barbara Channel.

However, in a recent paper, Shaw and Suppe (1994) have questioned the existence of an offshore Oak Ridge fault. Instead, they utilize geophysical data to interpret the presence of a separate structural fold referred to as the Oak Ridge trend.

The rugged, steep terrain of the north slope of South Mountain suggests that at least that portion of the Oak Ridge Fault is active.

The lack of surface evidence of fault displacement in the Oxnard Plain is not necessarily indicative of recent geologic activity because surface features could easily have been obscured by fluvial processes (erosion or deposition of alluvium). Several recorded earthquake epicenters in the offshore, as well as mainland area during historical time, may have been associated with the Oak Ridge fault or other faults that are within close proximity and associated with the Oak Ridge fault.

Subsurface data in conjunction with an estimated age for the top of the Saugus Formation of about 200,000-400,000 years ago suggest a slip rate of 5.9-12.5 mm/yr for the Oak Ridge fault at South Mountain (Yeats, 1988). From that slip rate, Yeats (1988) has estimated a recurrence interval of about 250-500 years for large-magnitude earthquakes (3 meters of slip per event) on the fault.

The fault system is considered active and a portion of the fault near the Bardsdale Cemetery has been delineated as an Alquist-Priolo fault-hazard zone by the California Division of Mines & Geology.

## VENTURA-PITAS POINT AND COUNTRY CLUB FAULTS

The Ventura fault has been mapped along the base of the hills south of Sulphur Mountain extending from north Saticoy westerly to the mouth of the Ventura River then westerly an unknown distance into to Santa Barbara Channel area. The fault is referred to as the Pitas Point fault where it extends offshore. The possible existence of the fault as well as the nearby Country Club fault northerly of Montalvo was reported in "Geology Seismicity and Environmental Impact" (1973), a special publication of the Association of Engineering Geologists. The Ventura-Pitas Point fault system dips north and exhibits reverse separation.

Evidence for the existence of the Ventura fault is based mainly upon minor faulting of terrace deposits north of San Buenaventura and evidence of faulting from the Tidewater Oil Company corehole #5. The existence of the Country Club Fault is based mainly upon discontinuities of water wells located in the Saticoy vicinity.

Yeats (1982) questioned whether the Ventura fault, or even the Pitas Point fault, extends to seismogenic depth. He suggests that the Ventura fault and the near-surface features associated with it are the result of folding, not deep-seated, seismogenic faulting.

Geologic mapping and subsurface exploration in the Ventura area have confirmed the location and Holocene activity of the fault, and provided estimates of its displacement (Sarna-Wojcicki et al., 1976; Prentice and Powell, 1991; Staal Gardner & Dunne, 1991).

The fault system is considered active and a portion of the fault in the city of Ventura has been delineated as an Alquist-Priolo fault-hazard zone by the California Division of Mines & Geology.

#### RED MOUNTAIN/SAN CAYETANO/SANTA SUSANA/SAN FERNANDO FAULT SYSTEM

This fault system consists of a major series of north-dipping thrust faults, which extend over 150 miles from Santa Barbara County into Los Angeles County. The system is associated with an intense zone of folded and faulted bedrock. Relationships within the system become obscure over an eight-mile wide gap between the Red Mountain and San Cayetano faults where those north-dipping faults give way to several large, south-dipping faults.

Geologic evidence that the fault system should be considered active throughout its length is shown by location of earthquake epicenters (including the San Fernando Earthquake of 1971), groundwater barriers, and displaced alluvial sediments. In addition, the unusually high fluid pressures in the Ventura and San Miguelito oil field are believed to indicate that tectonic stress has accumulated along that section of the fault system between the Red Mountain and San Cayetano faults. It is possible that continued buildup of that stress will eventually result in sudden release, probably in the form of an earthquake, resulting from movement along one or more of the faults within the Ventura County portion of the system.

In May 1997, a trench was excavated across the trace of the Red Mountain fault about 1 km east of Punta Gorda. Preliminary results of that trenching are summarized in Anderson and O'Connell (1998). Geologic relationships exposed in the trench indicate a long, complex, and ongoing history of repeated earthquakes and associated deformation from the Red Mountain fault. At that location, the most recent surface-rupturing event on that fault appears to have occurred in the late Holocene, possibly within the last 2,000 years (Anderson and O'Connell, 1998).

Research has shown that the San Cayetano fault, which has been divided into an eastern segment and a western segment by Rockwell (1988), has about 20,000 feet of displacement several miles east of Ojai Valley. The epicenter of an earthquake of magnitude 4.0 to 4.4 (Richter Scale) was located above the San Cayetano fault between Fillmore and Piru.

The Red Mountain/San Cayetano/Santa Susana/San Fernando fault system is considered active.

## SANTA YNEZ FAULT

This fault extends from Point Conception in Santa Barbara County, across the central portion of Ventura County, to near the eastern County line. It is considered to be one of the major faults in the region and is about 90 miles long. Past displacement has been about 10,000 feet of relative uplifting of the south side of the fault. The fault lies about 4 miles north of Ojai.

Left-lateral displacement of streams crossing this fault has been cited as evidence for recent fault movement. Several earthquake epicenters have been located along this fault and one or two of these were in Ventura County. The strong 1927 earthquake centered west of Point Conception may have originated on the westerly, offshore extension of this fault.

This fault is considered potentially active until additional information is available for evaluation.

## FAULTS BETWEEN THE SANTA YNEZ AND NORTH COUNTY LINE

Several large faults occur in the mountainous area north of the Santa Ynez fault and within Ventura County. The most significant of these faults are the Tule Creek, Munson Creek, Aqua Blanca, Frazier Mountain, and Big Pine faults.

Of those, the more important appear to be the Pine Mountain Thrust and Big Pine Faults (9 and 16 miles north of Ojai, respectively). The Pine Mountain Thrust is north-dipping and favorably oriented for generating earthquakes in response to the north-south compressive forces which have triggered activity along such similar faults as the Malibu, San Fernando and San Cayetano.

Terrace deposits and stream channels have been offset by geologically recent movement along the Big Pine fault. More importantly, it is reported to have ruptured the ground surface for a distance 30 miles along its length during the northern Ventura County earthquakes of November, 1852.

Both of those faults are considered active.

## SAN ANDREAS FAULT

The San Andreas is the longest and perhaps most important fault in California. That historically active fault has a length of over 960 kilometers and forms the tectonic boundary between the Pacific Plate to the west and the North American Plate to the east. Several major earthquakes have been recorded on the San Andreas fault, and it is generally considered to pose a significant earthquake risk to California.

The San Andreas fault has been divided into several segments (Working Group, 1988; Working Group on California Earthquake Probabilities, 1995; CDMG, 1996). The Carrizo segment of the San Andreas fault extends from southeast of Cholame for approximately 90 miles. The estimated recurrence interval for earthquakes along that segment of the fault is 206 years, with a slip rate of 34+ 3 millimeters per year, and a displacement of about 7+ 4 meters (Working Group on

California Earthquake Probabilities, 1995). The Mojave segment of the San Andreas fault extends almost 200 miles southeastward from the end of the Carrizo segment to the Cajon Pass. The estimated recurrence interval for earthquakes along that segment of the fault is 134 years, with a slip rate of 30+ 8 millimeters per year, and a displacement of about 4.4+ 1.5 meters (Working Group on California Earthquake Probabilities, 1995).

The San Andreas forms a one-half-mile-wide fault zone in the extreme northeastern corner of Ventura County, about 40 miles north of Camarillo. The faults are within an Alquist-Priolo Fault Hazard Zone.

Due to clearly established historical earthquake activity and paleoseismic evidence documenting prehistoric earthquakes, the State Division of Mines and Geology has designated this fault as active. The last major earthquake generated along that portion of the fault in Ventura County was in 1857. That earthquake is estimated to have been on the order of moment magnitude 7.9 and would have caused considerable damage to structures in the southern County area had they been there. The occurrence of another such major earthquake along the San Andreas fault is considered likely within the near future.

## LOCAL DISCUSSION

### LOCAL INVENTORY OF THE POTENTIAL HAZARD

The Camarillo area is transected by several faults (See Hazards Plate I) most of which are associated with the Simi-Santa Rosa fault system. That fault system extends into the Camarillo area from the east. Since the late 1980s, numerous subsurface fault-exploration studies have been performed along faults of the Simi-Santa Rosa system both within the City of Camarillo and in the adjacent Ventura County area and other nearby city jurisdictions. At several locations, including Camarillo, Moorpark, and Simi Valley, there is evidence that geologically young deposits have been cut by the fault system.

Almost no information is available for the Bailey fault, which extends from the Mugu Lagoon area northerly to an apparent intersection with the Camarillo fault near Calleguas Creek and Highway 101, thence northeasterly into the Santa Rosa Valley. Similarly, there is no information about a possible, unnamed, northeast-trending fault near Calleguas Creek between the Camarillo and Las Posas Hills. Water-well data suggest the existence of groundwater barriers or cascades along the trend of those postulated faults. However, insufficient information is available to conclude that such a condition is associated with active faulting.

No earthquakes of moment magnitude 4.0 or greater have been recorded on any of the local faults during historical time. Several shocks of less than 4.0 magnitude have been centered in the area, but whether those shocks were associated with any of the known faults is unknown. In the Camarillo and adjacent areas, geomorphic data indicative of recent fault activity include a warped Holocene alluvial surface, abrupt changes in gradient at the toes of slopes, linear mountain

fronts, ponded and offset slopewash, arcuate lineaments in alluvium that have been demonstrated to be coincident with shallow thrust faulting, and left-lateral deflections of several stream channels.

Recent geologic studies for private development projects have demonstrated near-surface fault disturbance of Holocene earth materials along the western portion of the Springville fault in the Spanish Hills development. Similar findings in the Tierra Rejada (Gorian and Associates, 1994) and Simi Valley (Hitchcock et al., 1997; 1998) areas have confirmed the Holocene activity of the Simi-Santa Rosa fault system.

The Simi-Santa Rosa fault system is active and evidence of recurrence from the Spanish Hills development suggests that the system could generate another large earthquake within the next few hundred years.

Therefore, the fault poses both a surface-rupture potential and a seismic shaking potential to the residents of the city of Camarillo.

## RESOURCES AFFECTED BY THE POTENTIAL HAZARD

Hazard Plate I was constructed by overlaying the State of California's Official Earthquake Fault Zone boundaries and faults on a city of Camarillo street base map. Comparison of that map with present land use areas indicates that several schools, commercial and industrial areas, and other public and vital facilities areas and utility facilities are within those official earthquake fault zones.

However, present information is not sufficiently detailed to conclude that any structures or facilities are definitely underlain by active faults.

The following resources inventoried for the City of Camarillo may be of significant concern in a time of disaster. These include schools, hospitals, city hall, police and fire stations, large meeting places, major utility lines, and other significant land uses that may be needed in a time of disaster.

There are three Alquist-Priolo fault zones that extend through various portions of Camarillo: the Springville, Camarillo, and Wright Road fault zones. Las Posas school is within the Springville fault zone, and Camarillo High School and St. Mary Magdalen Elementary School are in the Camarillo fault zone. The fire station located on the northwestern corner of Santa Rosa and Woodcreek Roads is just west of the boundary of the Camarillo fault zone, but faults encountered on the lot across the street on the northeastern corner project toward the fire station area. No Camarillo schools are within the Wright Road fault zone.

Of areas in which there could be large concentrations of people, only the shopping centers along Santa Rosa Road and a portion of the Camarillo Premium Outlet stores south of the Ventura Freeway are within the Camarillo fault zone. The Marriott Courtyard Hotel is also located within the boundaries of the Camarillo fault zone.

Major gas, sewer and water lines on Las Posas, Santa Rosa, and Lewis Roads lie within the state-designated active-fault zones.

## DEFINITION OF THE FAULT HAZARD ZONE

The Alquist-Priolo Earthquake Fault zones define areas where geologic studies are required because active faults are believed to be located in those zones. Those zones, which are based on available geologic data and the judgment of the California Division of Mines and Geology, are plotted on Hazard Plate I.

Faults not included in the Alquist-Priolo Earthquake Fault zones are presently considered by the Division of Mines and Geology to be either not well enough located or not sufficiently active to warrant zonation. Although that does not mean that all other faults are inactive, the implication of lesser activity appears reasonable. Therefore, for a planning document such as the Seismic Safety Element, Camarillo-area faults outside of the Alquist-Priolo Earthquake Fault Zones are assumed not to pose a significant threat of hazard.

Another set of Camarillo area fault zone maps is available in the Geotechnical Report Guidelines issued by the City of Camarillo. Those fault zone maps were developed primarily for use by geologists and engineers working on new developments in the City. The City requires geotechnical exploration and evaluation for proposed developments within those zones also. The fault zones shown on the geotechnical Guidelines maps are different than those shown on the State's Alquist-Priolo maps. Those maps show more faults and larger fault-hazard zones, because no attempts were made to determine the activity of faults shown on the geotechnical Guidelines maps. Because the Guidelines maps are in the process of being revised, only the State's zones are being used for this planning document.

A fault is defined as a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side. Most major faults are the result of repeated displacement, which may have taken place suddenly and/or by slow creep. Zones of fracturing or deformation may develop near main faults, commonly as a result of bending or drag folding of the rocks adjacent to the main fault rupture. A fault zone is a zone of related faults that commonly are braided and subparallel, but may be branching and divergent. Fault zones have significant width (with respect to the scale at which the fault is being considered, portrayed, or investigated), ranging from a few feet to several miles. Subsidiary faults within a fracture zone, a deformation zone, or a fault zone may exhibit repeated small ruptures along the same planes or they may exhibit individual breaks of perhaps several inches during different earthquakes without the same surfaces breaking again.

A fault trace is the line formed by the intersection of a fault and the earth's surface. The fault trace also is the representation of a fault on a map.

Any fault considered to have been active during Quaternary time (last 1,600,000 years) - on the basis of evidence of surface displacement - is considered to be potentially active. An exception is a Quaternary fault that is determined, from direct evidence, to have become inactive before Holocene time (last 11,000 years). Such a fault is

presumed to be essentially inactive and is generally omitted from Alquist-Priolo Earthquake Fault Zone maps. In contrast, the State Mining Geology Board, in their Policies and Criteria (adopted November 21, 1973), defined any fault that has had surface displacement within Holocene time as "active" and hence as constituting a potential hazard. "Although faults shown on Alquist-Priolo maps may have been active during any part of, or throughout, Quaternary time, evidence for the recency of displacement typically is incompletely preserved and often is equivocal.

## USES & LIMITATIONS OF THE POTENTIAL HAZARD

The purpose of Alquist-Priolo Earthquake Fault zones is to define those areas where special studies would be required prior to building structures for human occupancy (a "structure for human occupancy" is any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person-hours per year). Such a criteria may require site-specific studies within the zone to determine if a potential hazard from any fault, whether heretofore recognized or not, exists with regard to proposed structures and their occupants.

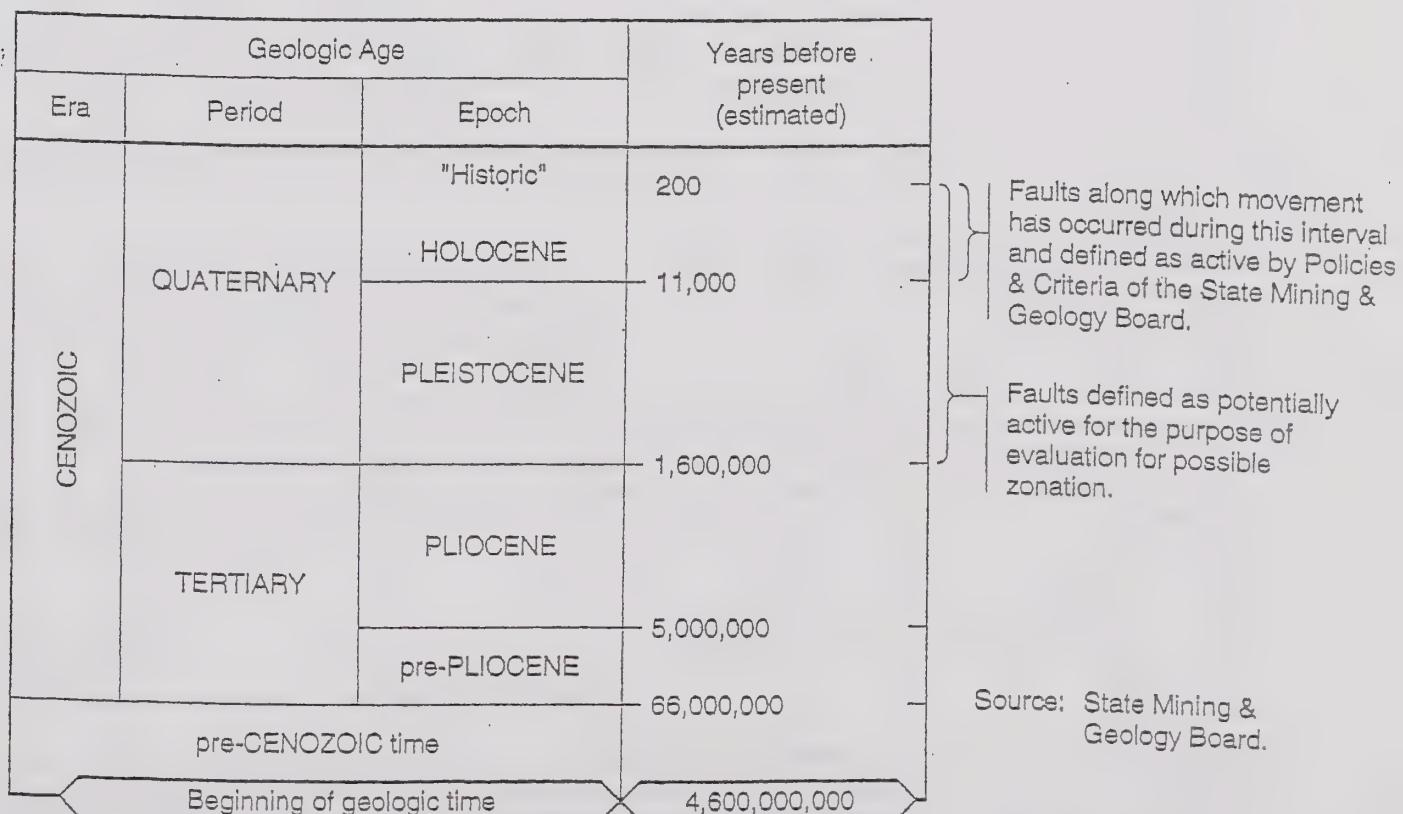
Such studies should be required both for Alquist-Priolo Earthquake Fault Zones and the fault zones shown in the City's Geotechnical Report Guidelines.

June 1990  
Project No. 08-42-0761



## ILLUSTRATION 2, GEOLOGIC TIME SCALE

June 1999  
Project No. 98-42-0751



Users of the maps should be fully aware that the zones are delineated to define those areas within which special studies may be required prior to building structures for human occupancy.

Traces of faults are shown on the maps mainly to justify the locations of zone boundaries. Those fault traces are plotted as accurately as the sources of data permit; yet the plots are not sufficiently accurate to be used as the basis for developing setback requirements.

The fault information shown on the maps is not sufficient to meet the requirement for special studies. The onus is on the local government agencies to require the developer to evaluate specific sites within the special studies zones to determine if a potential hazard from any fault, whether heretofore recognized or not, exists with regard to proposed structures and their occupants.

### NATURE OF INFORMATION

The geologic information relating to the location of faults and their potential for activity is based largely upon past regional geologic studies conducted by universities and petroleum geologists, as well as information compiled by the State Division of Mines and Geology and the County Department of Public Works. The most recent regional geologic information for the city area is contained on geologic maps prepared by the Dibblee Geological Foundation. Another, regional map was contained in a report entitled "Geology and Mineral Resources Study of Southern Ventura County," Preliminary Report 14, 1973, prepared by the Division of Mines and Geology in cooperation with the County of Ventura Department of Public Works.

The City of Camarillo Reconnaissance Geohazard Assessment, adopted in 1987, generally assesses the geologic, geotechnical, and slope conditions within the city and was used in the preparation of the hillside development ordinance. That report established guidelines for reviewing developments in regard to potential geohazards in Camarillo. The report was prepared using data from existing geohazards and soil studies in Camarillo and includes maps of faults, slope areas, geologic formations, and landslides. Informal revisions were made to that document in the early 1990s, but in 1999, the Geohazard Assessment document is to be officially revised and updated.

### MANAGEMENT RESPONSIBILITY

#### WARNING

Presently there is no way to prevent or accurately predict when an earthquake and surface displacement is apt to occur along a given fault. The state-of-the art is such that at best only the general recency of past activity can be determined along some faults.

In addition, in some cases, regional studies can indicate those systems of faults that may be potentially the most active. For example, in the southern California area, those faults that have generally east-west trends or are associated with the northwesterly trending San Andreas fault are considered to be potentially the most

active. There are indications that some degree of earthquake prediction might be possible in some areas of the United States in the future. It is not known whether this will be one of those areas.

However, there are serious social and economic problems with predicting earthquakes that must be evaluated before earthquake predictions can be utilized, if and when they are perfected.

## ALLEVIATION

Regulation of public and private land development within the City of Camarillo is administered by:

Department of Planning and Community Development  
Department of Engineering Services  
City of Camarillo Building and Safety Department  
City of Camarillo Planning Commission and City Council

Enforcement of the Uniform Building Code and city regulations and policies can be affected by the above agencies through requirement of review of proposed land use and evaluation of investigations and engineering studies for private development of public projects. Such reviews and evaluations can be performed by qualified geologic and soils engineering staff or by retention of qualified consultants.

Effective control of the Fault Hazard can only be achieved through knowledge of the location and potential for, activity of faults and implementation of development controls within the hazard zones.

Because alleviation of the hazard is largely accomplished through land use controls, the agencies, departments, and legislative bodies making land use decisions have the primary responsibility for alleviating the hazard. The Planning Department can utilize available hazard information to avoid improper land uses. Decisions concerning adoption of these recommendations rest ultimately with the Planning Commission and City Council.

Alleviation of existing hazards can be effected by removal of structures located over, or strengthening structures in hazardous proximity to, potentially active faults. Determination of whether structures are hazardously located would require detailed study of geologic conditions and of the potential for activity along any faults found.

## FINDINGS

### PROBABILITY OF OCCURRENCE

The level of the hazard from fault displacement within Camarillo is not completely known. However, several investigations for recent private developments along some of the faults of the Simi-Santa Rosa fault system have documented displacement of Holocene earth materials, demonstrating the fault system is active. On the basis of evidence obtained from fault trenches excavated on the Spanish Hills development, the Simi-Santa Rosa fault system may have a recurrence interval on the order of about 1,000 years with the last event having occurred about 900 years ago. No evidence of activity along the Bailey fault has been discovered, possibly because evidence for that

zone is limited and exploration is generally lacking for the fault. The potential for activity along other faults in the area is unknown.

The City requires that private developments in proximity to known or conjectured faults associated with the Simi-Santa Rosa fault zone conduct studies to identify geotechnical hazards and develop mitigation measures that reduce the hazards. Those studies also assist in expanding the city's knowledge of geotechnical hazards. Additional information concerning the possible presence of potentially active faults within the City is still needed to fully evaluate the level of the hazard.

## SEVERITY OF THE POTENTIAL HAZARD

Experience has shown that damage to structures placed over faults along which sudden surface displacement occurs can be substantial. For example, in the San Fernando earthquake of 1971 and the Landers earthquake of 1992, surface fault displacement significantly damaged structures. Although the hazard of surface rupture is considered real within Camarillo, the effect of the hazard is low compared to the likelihood of greater losses that could occur as a result of strong earthquake shaking. In recognition of that greater potential, the State passed the Seismic Hazards Mapping Act in 1990, which requires the assessment and mitigation of seismic hazards such as ground shaking, liquefaction, and seismically induced slope instability. To implement that act, the State Division of Mines and Geology is in the process of developing maps of areas where seismic hazard assessment and mitigation are required for new developments. Those maps are not yet available for the city of Camarillo, but they should be available by the year 2000.

## RESOURCES AFFECTED

Comparison of the Alquist-Priolo Earthquake Fault Zone maps and city's geohazards maps with the present land use areas within Camarillo indicates that some schools, commercial and industrial areas, rest homes, and other public and vital facilities are present within the hazard zones. However, present information is not sufficient to definitely conclude any structures are underlain by active faults. That is largely a result of new-development policies that have been in effect in the city since the late 1980s, which have required exploration for faults and setbacks from them, if found.

## NATURE OF INFORMATION

Present information is not considered sufficiently accurate to warrant special investigation for most existing development. Consideration should be given, however, to the safety of vital or emergency facilities over or near known faults. As more detailed information on fault locations is developed, the City will undertake further evaluation of existing structures and facilities.

## OTHER FINDINGS

Camarillo has utilized private engineering geologic and soils engineering review services since November, 1972, on an as-needed basis. Since that time, reports concerning seismic, as well as geologic, conditions have been reviewed by city staff prior to city approval of the projects.

Presently, new developments are reviewed in accordance with the city's Guidelines for Geotechnical and Geologic Reports to help detect and mitigate geologic hazards.

## RECOMMENDATIONS

1. Consider all faults (whether zoned or not) shown on the city's Reconnaissance Geohazards Assessment maps and the State's Alquist-Priolo Earthquake Fault Zone maps as potentially hazardous unless detailed seismic-geologic investigation confirms the contrary.
2. No buildings or other structures whose failure could result in damage to life and property to be placed over any fault lines should be allowed unless detailed geologic seismic investigation proves that the fault is inactive (has not experienced displacement within about the last 11,000 years).
3. Encourage and participate in cooperative studies with adjoining cities, county, state, and federal agencies.
4. Continue to adopt the most recent and current Uniform Building Code.
5. Land development reports and plans submitted should be reviewed by qualified personnel registered and certified by the State.
6. Require geologic-seismic investigation for all major projects such as multi-story buildings, industrial installations, buildings of a semi-public or public nature, large commercial buildings, large utility and storage facilities, and major trunk lines proposed anywhere within the City.
7. Consider mitigating measures within the hazard zones such as modification of existing or proposed structures and facilities
8. Administration of Alquist-Priolo and City Fault Hazard Zones.

In the interest of consistency and standardization, the Specific Criteria Section (Modified) of the Policies and Criteria of the State Mining and Geologic Board and the State Geologist's Explanation of

the Special Studies Zones Maps (Modified) should be adopted for administration of these zones and are as follows:

- a. No structure for human occupancy shall be permitted to be placed across the track of an active fault. Furthermore, the area within fifty (50) feet of an active fault shall be assumed to be underlain by active branches of that fault unless and until proven otherwise by an appropriate geologic investigation and submission of a report by a geologist registered in the State of California. This 50-feet standard is intended to represent minimum criteria only for all structures. Certain essential or critical structures, such as high-rise buildings, hospitals and schools should be subject to more restrictive criteria at the discretion of the City Engineer.
- b. Application for all real estate developments and structures for human occupancy within fault hazard zones shall be accompanied by a geologic report prepared by a geologist registered in the State of California, and directed to the problems of potential surface fault displacement through the site unless studies are waived pursuant to Section 2623 (State Code).
- c. Requirements for geologic reports may be satisfied for a single 1- or 2-family residence if, in the judgment of technically qualified city personnel, sufficient information regarding the site is available from previous studies in the same area.
- d. Technically qualified personnel within or retained by city must evaluate the geologic and engineering reports required herein and advise the body having jurisdiction and authority.
- e. The city may establish policies and criteria that are more restrictive than those established herein. In particular, comprehensive geologic and engineering studies should be required for any "critical" or "essential" structure as previously defined whether or not it is located within a fault hazard zone.
- f. Those facilities which are not critical, but which do have high occupancy potential such as theatres, churches, major markets, apartment complexes, and so forth, should not be planned within Alquist-Priolo Earthquake Fault Zones. Those that may presently be in Alquist-Priolo Earthquake Fault Zones should be replaced as soon as possible by facilities confirmed to be safely located.
- g. Unless entire Alquist-Priolo Earthquake Fault Zones were to become open space, which may not be feasible, low density, well-built, timber construction homes are an acceptable planned use within the area. However, since any construction in fault corridors presents some additional hazard to life, and may result in considerable property loss, it would be best if these areas could be

devoted to open space of some sort.

- h. Important facilities must be kept off areas where faults are anticipated. When such facilities must be located in those areas, provisions must be made to locate and avoid specific faults by using structural setbacks.
- i. Noncritical facilities should be kept off actual fault breaks, but could be located near them if adequate compensation is made in the construction for potential deformation associated with the nearby fault movement.
- j. As used herein, the following definitions apply:
  - (1) A "structure for human occupancy" is any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person-hours per year.
  - (2) An engineering geologist certified in the State of California is deemed to be technically qualified to evaluate geologic reports to be used in the design of civil works.
  - (3) Any engineer registered in the State of California in the appropriate specialty is deemed to be technically qualified to evaluate engineering reports in that specialty.

## EARTHQUAKES & GROUND SHAKING

### GENERAL DISCUSSION

By far the greatest damage done by an earthquake is caused by the ground shaking, not fault rupture. This section, therefore, is the companion section to the fault displacement hazard section. One of the very serious side effects of ground shaking is liquefaction, which is also covered as a separate hazard.

The probability of an earthquake is determined by a number of factors, but basically, by the location of active faults in an area and the rate that tensional and compressional forces are developed against those faults.

California is interlaced with hundreds of active faults. The most important system is the San Andreas fault (system), which extends from south of Los Angeles to north of San Francisco. The main branch of that fault runs through the extreme northeast corner of Ventura County. That fault has been responsible for at least two major earthquakes; the San Francisco earthquake of 1906 and the Fort Tejon earthquake of 1857. The Earthquake of 1857 is reported to have caused severe shaking in the then undeveloped southern portion of Ventura County.

In addition to the forces causing horizontal movement, such as those predominant along the San Andreas fault, Ventura County and portions

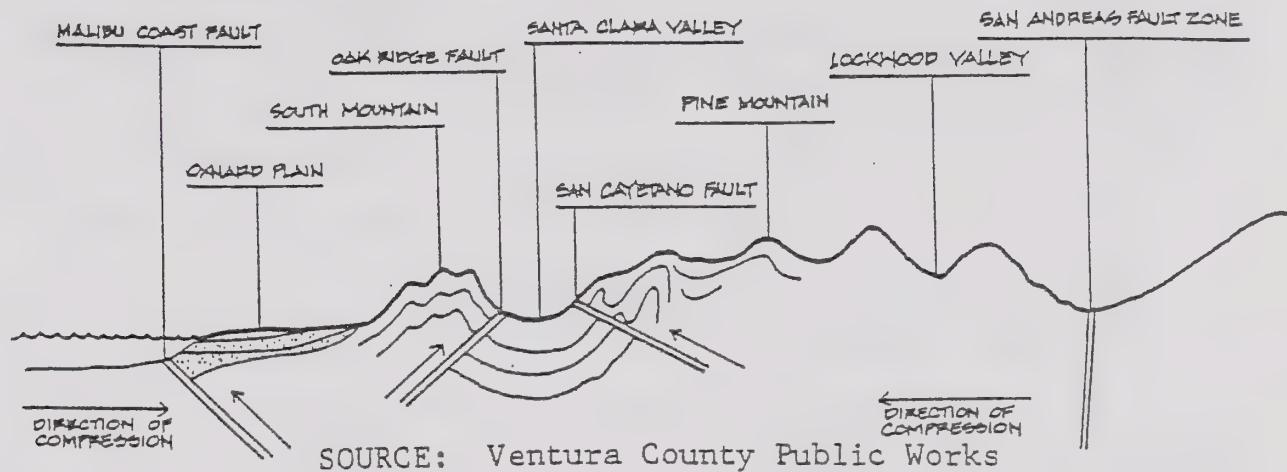
of adjacent areas are subject to compressional forces acting in north-south directions. These latter forces tend to compress or try to shorten the distance from the San Andreas fault south to the coast. The San Fernando earthquake of 1971, resulting in the thrusting of the southern margin of the San Gabriel Mountains several feet southward over the northern margin of the San Fernando Valley, was caused by those compressional forces. Several faults in Ventura County have been formed by and are related to those same forces (See Illustration 3). Those fault systems are described in the Fault Displacement Hazard section.

When an earthquake occurs, the break along the fault plane begins in a small area and rapidly propagates out along the fault plane. The point of first release of stress located below the earth's surface on the fault plane is called the earthquake focus (or hypocenter). The point at the earth's surface vertically above the focus is the epicenter.

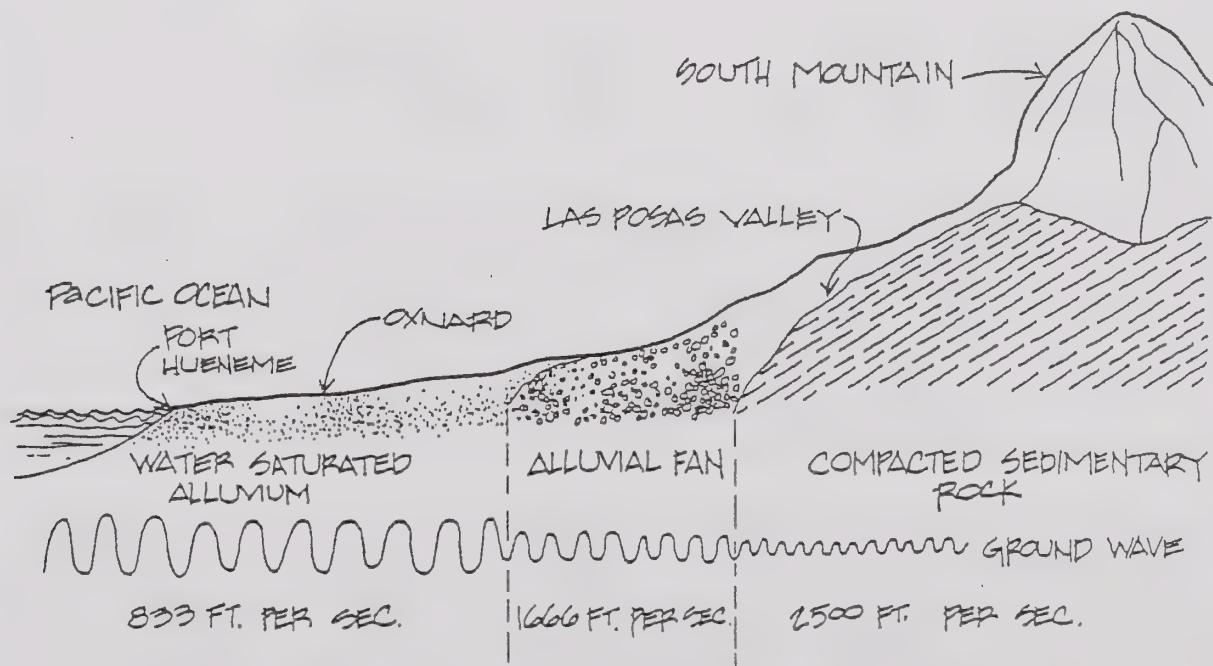
A simplified north-south cross-section showing the relationship of thrust faulting to presently active compressional forces.

## ILLUSTRATION 3 AND ILLUSTRATION 4

### ILLUSTRATION 3



### ILLUSTRATION 4



### Changes In Ground Wave Speed

When a fault breaks, the accumulated strain energy is released as seismic waves. Those waves travel outward in all directions from the earthquake focus. Each of the waves has different types and directions of movement. Each can affect buildings slightly differently depending on many diverse variables. The combined effect of those waves makes up the ground-shaking component of an earthquake.

In general, research of many past earthquakes indicates that the intensity of ground shaking at any given location during an earthquake is a function of several factors including:

1. Magnitude of the earthquake
2. Distance from the earthquake to the site
3. Depth at which the earthquake was generated
4. Type of fault rupture
5. Geologic structures at the location
6. Soil conditions at the location
7. Geology along the earthquake-wave travel-path

Of these, the only variable that generally can be assessed in advance is the soil conditions at the location. Determination of ground response (ground wave motion) can be estimated based largely upon existing earthquake records, though only for a specified location and magnitude of an earthquake.

The intensity of ground shaking during an earthquake depends in large part on geologic foundation conditions (i.e., thickness and physical properties of the materials that form the upper several hundred feet beneath the area). In general, the greatest amplitudes and longest duration of ground shaking usually occur on thick, water-saturated, unconsolidated alluvial sediments. Ground motion studies in San Francisco following the 1991 Loma Prieta earthquake demonstrated that ground motions were significantly greater on soils adjacent to the bay than on nearby bedrock.

Illustration 4 is a diagram of the area from South Mountain near Fillmore to Port Hueneme, which shows the hypothetical slowing down of the ground wave as it passes from consolidated sedimentary rocks on South Mountain to the alluvial fan materials of the Las Posas Valley along with a corresponding increase in wave amplitude. An increase in wave amplitude generally means an increase in intensity of ground shaking. There probably is even a more marked decrease in speed and increase in amplitude between the alluvial fan materials of the Las Posas Valley and the water-saturated sediments of the Oxnard Plain.

Measurement of the radiated energy released by an earthquake was originally proposed by C. F. Richter in 1932 and utilizes a system of tables and charts to deduce from seismological instruments a method of measuring the magnitude of an earthquake. The magnitude assigns a number to the calculated energy release and the system can rank earthquakes and compare them one to the other. By this method, an earthquake is rated independently of the place of observation.

The Richter magnitude is proportional to the logarithm (Base 10) of the maximum amplitude of a seismogram referred to a distance of 100

kilometers (62 miles) from the epicenter. Under that system, an increase of one unit in magnitude is equal to a 32 times increase in the amount of energy released. Thus, an earthquake of magnitude 7 represents about 32 times as much energy release as one of magnitude 6; magnitude 8 represents 32 times the energy of magnitude 7 and, therefore, about  $(32 \times 32)$  1,000 times the energy of magnitude 6. Because the Richter magnitude scale is only considered accurate up to a "saturation" magnitude of about 7.5 (at which point increasing earthquake size does not result in a larger earthquake magnitude), most seismic hazard analyses performed today utilize the more robust Moment Magnitude Scale. Moment Magnitude can be computed using fault rupture dimensions and rock properties, which yield a scale that is accurate for earthquakes of all magnitude.

## CHANGES IN GROUND WAVE SPEED

An important factor affecting the degree of damage to structures during an earthquake is the frequency characteristics of ground motion as related to the fundamental periods of vibration of the structure.

For areas such as the Oxnard Plain, that are underlain by deep deposits of unconsolidated alluvium, larger spectral acceleration values tend to occur at higher values of the fundamental. Higher spectral acceleration values result in higher (damaging) accelerations being induced in flexible structures such as multi-story buildings. The reverse is true in areas underlain by firm bedrock (i.e., the largest accelerations would be induced in rigid structures such as reinforced buildings of only a few stories in height).

Greater damage is likely to occur when the vibration period of the ground and building are similar. That phenomenon is called resonance. The predominant vibration period of a building can be related in a very general way with its height or number of stories. Taller buildings have a longer predominant vibration period (2 or more seconds). Therefore, they are subject to greater damage where they are built on ground with a longer predominant vibration period (thick, water-saturated sediments). Conversely, 1- or 2-story buildings with short predominant vibration periods may experience resonance effects on firm ground. Other factors that contribute to damage potential, such as magnitude, distance, frequency and duration of a particular earthquake, can influence the predominant vibration period. For the Ventura County area, unfortunately, none of the factors are predictable with any great degree of confidence.

Intense ground shaking in areas of unconsolidated, water-bearing sediments (alluvium) or wet soils could also result in soil liquefaction, ground rupture, lurching, slumping and lateral movement of nearly level areas, and landsliding. The greatest hazard of ground failure in hillside areas is in the form of landsliding and other slope failures. Seismic shaking can renew movement of old landslides as well as result in formation of new slides.

Many existing landslide features may have been triggered by past earthquake shaking. The combination of a relatively weak bedrock, deep weathering, steep slopes, and inclined bedding combine to make

many areas highly susceptible to landslide failure during seismic shaking.

The following are excerpts from a manuscript prepared by D. R. Nichols, U. S. Geological Survey.

**Ground Failure** - Earth materials in a natural condition tend to reach equilibrium over a long period of time. In geologically active areas such as California and Alaska there are many regions where earth materials have not yet reached a natural state of stability. For example, most of the valleys and bay margins are underlain by recent loose materials that have not been compacted and hardened by long-term natural processes. Landslides are commonly found on hills and mountains as loose material moves downslope. In addition, many activities of man tend to make the earth materials less stable and hence tend to increase the chance of ground failure. Some of the natural causes of instability are earthquakes, weak materials, stream and coastal erosion, and heavy rainfall. Human activities that contribute to instability include oversteepening of slopes by undercutting them or overloading them with artificial fill, extensive irrigation, poor drainage or even groundwater withdrawal, and removal of stabilizing vegetation. These causes of failure, which normally produce landslides and differential settlement, are augmented during earthquakes by strong ground motions that can result in rapid changes in the state of earth materials. It is those changes that result in many landslides during earthquakes as well as differential settlement, subsidence, ground cracking, ground lurching, and a variety of transient and permanent changes in the ground surface.

**Mechanisms of Failure** - Liquefaction is a common mechanism causing many types of ground failure. It occurs when the strength of saturated, loose, granular material (silt, sand, or gravel) is drastically reduced, such as may occur during an earthquake. The earthquake-induced deformation causes loose materials to densify, which causes an increase in pore-water pressure. The increase in pore-water pressure reduces the effective strength of the material, which transforms a firm granular material into a fluid-like state in which the solid particles are virtually in suspension similar to quicksand. The result, where the liquefied materials are in a broad buried layer, may be likened to the action of ball bearings in reducing friction in the movement of one layer of material over the top of another. The Juvenile Hall Landslide during the 1971 San Fernando earthquake resulted from liquefaction of a shallow sand layer and involved an area almost a mile long and a failure surface that had a slope of only 2-1/2% (Youd, 1971, P. 107, 108). Where the liquefied granular layer is thick and occurs at the surface, structures may gradually sink downward due to the loss of bearing support. The dramatic tilting and sinking of buildings during the Niigata, Japan earthquake illustrate that phenomenon.

## GENERAL EFFECTS OF THE POTENTIAL HAZARD

### **PRIMARY EFFECTS**

Damage to structures during ground shaking can range from minor cracking of plaster to total collapse and/or overturning. No structure can be assured to be designed and constructed to withstand

damage from a strong earthquake. Some damage, whether it is to the structure or its contents, can be anticipated.

Ground shaking could cause severe damage to most utilities including pipelines, power lines, generating and converter facilities, roads, and bridges, if such structures were not constructed to withstand the shaking. Ground surfaces could rupture, crack, and subside up to several feet in areas of unconsolidated alluvium resulting in damage to structures located in those areas.

## SECONDARY EFFECTS

As a result of severe shaking and structural failures, there are other secondary effects possible. Such effects include:

1. Cost of rehabilitation.
2. Disruption of utilities and services for a substantial length of time.
3. Seiches ("sloshing" waves in lakes, reservoirs, pools, etc.).
4. Liquefaction.
5. Possible sympathetic movement of other faults
6. Temporary and long-term psychological effects.
7. Adverse effect on the quality of water in groundwater aquifers.

## GENERAL INVENTORY

### LOCATION OF THE POTENTIAL HAZARD

The hazard exists throughout Ventura County and may significantly increase, wherever there is ground material that could significantly amplify the ground waves of an earthquake and produce high-intensity ground shaking. An earthquake would shake every place in the surrounding area and, the size of the area affected would generally be determined by the magnitude of the earthquake.

The highest amplification of ground shaking occurs in areas where the long-period wave shaking is greatest, designated as Area A on Hazard Plate II. Basically, those areas include the Oxnard Plain and the Santa Clara River in the southern half of the county and in Lockwood, Cuyama, and Cuddy Valleys in the northern half. Areas that could experience some amplification of long-period shaking generally surround those areas and extend up the canyons of the major rivers and creeks.

The areas with the greatest amplification of short-period shaking are along the base of the hills and in minor river valleys and in the broken bedrock along fault lines such as the San Cayetano and Simi-Santa Rosa Faults. Slight to moderate amplification of short-period oscillations may occur on terrace deposits or soft bedrock that have a thin soil covering. Those materials are found in young hill areas such as South Mountain, Oak Ridge, Sulphur Mountain, and the north

coastal hill lands and the Piru area in the southern half of the county. In the northern half, those are along the margins of the valley areas such as Hungry and Lockwood Valleys, and hilly lands north of Cuyama.

## HISTORY OF THE POTENTIAL HAZARD

### **SOUTHERN VENTURA COUNTY**

The history of strong earthquakes provides an indication of what will probably occur in the future; however, the record does not provide a statistically sound basis for prediction. Probably earthquakes of magnitude 6 and larger will occur in the future within the southern half of the county area or in the nearby offshore areas. The occurrence of several such shocks in the next century would be consistent with past experience. Surface displacement associated with such an earthquake also is possible.

The following is a portion of the summary of faulting and seismicity of the southern county area taken from the "Geology and Mineral Resources Study of Southern Ventura County" (1972) prepared by the State Division of Mines and Geology in cooperation with the Ventura County Department of Public Works:

"The earthquake history of Ventura County, particularly of the more populous southern part, is dominated by small to moderate shocks. Many of these shocks have been severe in their local, epicentral areas, but regionally have caused only light damage. No earthquake greater than magnitude 4.7 has been recorded in the Ventura County, or the immediate offshore area, since 1934 when adequate instrumental records became available. These relatively minor shocks have caused local damage but no recorded loss of life. A review of the earlier less accurate record from 1769 to 1934 suggests a similar history for the southern County region. More serious than effects from local shocks have been the effects from relatively numerous moderate to large earthquakes whose epicenters are located outside of southern Ventura County. These shocks have caused considerable damage but no recorded loss of life.

"Several larger, historic earthquakes are especially important to the evaluation of future seismic risk in southern Ventura County. On December 21, 1812, an earthquake, probably located offshore south of Santa Barbara, damaged missions from Purisima Concepcion, near Lompoc, to San Fernando on the south. The tower of the San Buenaventura Mission was wrecked and much of the facade had to be rebuilt. This earthquake was accompanied by seismic sea waves which had reported runup heights of 30 to 50 feet between Santa Barbara and Gaviota, and 15 feet or more at Ventura (Wood and Heck, 1966). Such waves today would do considerable damage to many parts of the now heavily settled coastal areas of Ventura County.

"On January 9, 1857, the great Fort Tejon earthquake, with its epicenter probably on the San Andreas fault, close to the northeast corner of Ventura County, caused significant damage in the southern part of the County.

"The roof of the Mission Church at San Buenaventura fell in (Townley

and Allen, 1939). Six miles from the mouth of the Santa Clara River the bed of the river was severely cracked. Wood (1955, p. 63) quoted a report describing the cracks as 'being six or eight inches across and extending in a direction SE and NW.' Quoting further, he said that 'on either side of the cracks lay a ridge of wet sand.' These cracks were probably due to lurching and liquefaction in the saturated alluvium of this area.

"Wood continued, noting: 'These appearances were visible as far as I could see up and down the bed of the river. Near the mouth of the river the cracks were longer and wider. Persons residing within a mile of the entrance say that the water was thrown out from the cracks as high as six feet, and that large blocks of earth sank several feet below the former level, and there remain.'

"A second important earthquake is the June 6, 1925 shock of magnitude 6.3, which destroyed the business section of Santa Barbara and caused some damage in Ventura. An offshore shock on June 30, 1941, magnitude 5.9, cracked some walls and plaster, broke windows and dishes and damaged considerable shelf stock in some stores in Ventura.

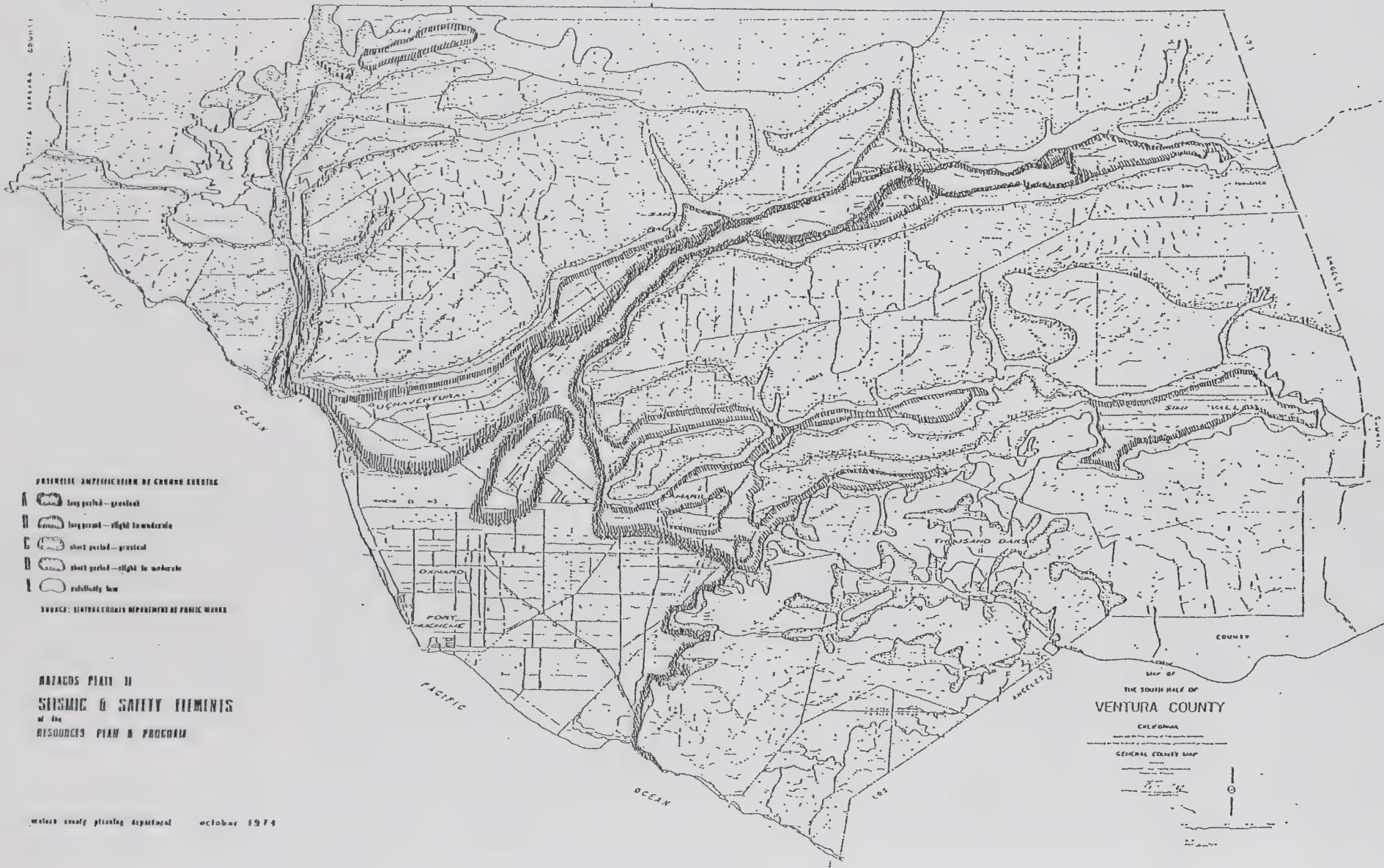
"The intensity of shaking reported in much of Ventura County from the February 9, 1971, San Fernando earthquake was sufficient to cause minor damage and to cause breakage of some goods thrown from store shelves. In Santa Susana, some older buildings were severely damaged, with at least one or two razed. At least a few rockfalls and one small bedrock landslide occurred north of Simi Valley in the Tapo Canyon area, just south of the Santa Susana fault.

"Small displacement occurred on this fault during the earthquake in the northwestern Sylmar area. The fault extends west, where it joins the Oak Ridge fault and possibly the San Cayetano fault in the Piru-Oak Ridge area.

"The question, 'which faults of southern Ventura County are active or potentially active?' has not been answered fully. The Red Mountain and San Cayetano thrust fault zones, which together nearly span the County (See Hazard Plate I), should be considered active. Holocene and Pleistocene sediments are displaced, and aerial photos show many ground surface lineaments and other phenomena which may reflect Holocene or later Quaternary faulting, and should be investigated."

HAZARDS PLATE II, SEISMIC & SAFETY ELEMENTS

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"Several reverse faults, which apparently act as barriers to ground water in the alluvial areas, were also probably active during the late Quaternary, as described by California Water Resources Board (1953). These include the Springville fault at the western Simi Valley area, and the western Oak Ridge (Saticoy) fault in the Oxnard Plain area. The Camarillo fault may not act as a ground water barrier, but California Water Resources Board (1953, p.B34) stated that the fault may have offset alluvium.

"A problem equally as serious is identifying the geologic units as to their seismic response characteristics. Richter (1959, p. 143) stated that much of the alluviated area of the Santa Clara Valley and the Ventura basin should expect shaking sufficient to cause considerable damage in specifically designed buildings and great damage to normally substantial buildings.

"In the eastern part of the Ventura basin, this was demonstrated during the San Fernando earthquake. The expected damage to areas where ground water is within 15 feet of the surface could be even greater, but would be relatively less in areas underlain by older alluvium and even less on more indurated or cemented Tertiary rocks.

Older landslides may be reactivated or new landslides may originate in some areas of Tertiary rocks of the County during an earthquake. Especially landslide prone is the Pico Formation, and to a lesser extent, the Modelo/Monterey and Rincon Formations."

Based upon the meager available information and experience with earthquake activity in California, an accurate prediction of the degree of shaking that could result from a great earthquake such as those of the not so distant past that affected the region is not possible. However, bedrock accelerations of over 1.0g (or equivalent to the acceleration of gravity) and over 45 seconds of maximum shaking duration can reasonably be expected. The degree of shaking could be much greater, resulting in higher accelerations, in areas underlain by alluvium or valley sediments. Peak bedrock accelerations in the range of 0.5g to 1.0g were recorded during the relatively small San Fernando earthquake of 1971 and Northridge earthquake of 1994.

## DEFINITION OF HAZARD ZONE

The ground-shaking hazard zones indicated on Hazard Plate II (Southern Ventura County and Northern Ventura County) are based on the concept that ground shaking is partly determined by the thickness of the alluvium or unconsolidated material overlying relatively firm bedrock or consolidated earth material and the depth to the ground water table. The zones identified are as follows.

Zone A Areas underlain by alluvium more than about 50 to 100 feet in thickness and with groundwater levels at about 15 feet or less below ground surfaces. Those areas could experience the greatest amplification of long-period ground vibrations. Therefore, buildings such as high-rise structures, which have long natural-vibration periods, could be more susceptible to damage in this zone.

Zone B (South County only) Areas underlain by alluvium more than about 50 to 100 feet in thickness and with groundwater levels more

than 15 feet below the ground surface. Those areas could experience moderate amplification of long-period ground vibration. Therefore, high-rise structures, which have long natural-vibration periods, could be more susceptible to damage in this zone, but less susceptible than in Zone A.

Zone C (South County only) Areas underlain by broken bedrock adjacent to faults or where ground alluvium is less than about 50 feet in thickness. Those areas could experience the greatest amplification of short-period ground vibration. Therefore, low-rise buildings, which have short natural-vibration periods, could be more susceptible to damage in this zone.

Zone D Areas underlain by soft sedimentary bedrock or terrace deposits with some soil cover (generally thicker on lower slopes) may not experience as severe shaking as the other zones. However, ground shaking should be greater than in Zone E because of softer materials and relatively thin soil cover. Amplification of short-period ground vibration could be slight to moderate. Therefore, low-rise structures of short natural-vibration periods could be somewhat more susceptible to damage.

Zone E Areas underlain by hard bedrock with little or no soil cover. These areas may not experience as severe shaking as the other zones because the thin or lack of unconsolidated cover (soil) or significant free groundwater will not allow amplification of shaking.

## LOCAL DISCUSSION

### LOCAL INVENTORY OF POTENTIAL HAZARD

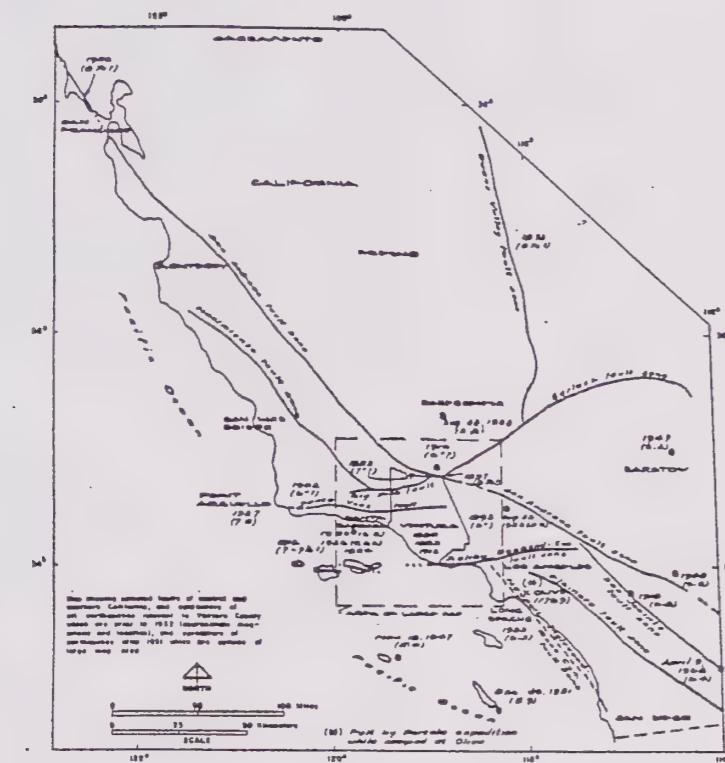
Primarily alluvial materials ranging from clay silt to sand of varying density and depth underlie the Camarillo area. The City's Reconnaissance Geohazards Assessment indicates that slope and non-slope areas of Camarillo are traversed by faults. The Assessment recommends that a local and regional seismic evaluation be made of new developments. In addition, past studies have indicated that during regional, strong earthquake shaking:

1. Low-rise buildings, which have short natural-vibration periods, could be more susceptible to damage in the city center area, and
2. High-rise structures, which have long natural-vibration periods, could be more susceptible to damage in the middle and central portion of the city.

CALIFORNIA DIVISION OF MINES AND GEOLOGY  
THOMAS E. SAY, JR., ACTING STATE GEOLOGIST

STATE OF CALIFORNIA  
THE RESOURCES AGENCY  
DEPARTMENT OF CONSERVATION

PREPARED IN COOPERATION WITH  
COUNTY OF VENTURA



#### EXPLANATION

##### FAULTS

A. ONSHORE Compiled from Jennings and Strand, 1959; Shabot and others, 1973 and present  
Early (1961-62) faults = Ventura County only  
— Faults identified and accurately located  
- Faults possibly identified and approximately located  
... Crossed  
B. OFFSHORE Compiled mostly from Zilly and others, 1974

##### EPICENTERS<sup>(a)</sup>

###### SYMBOLS

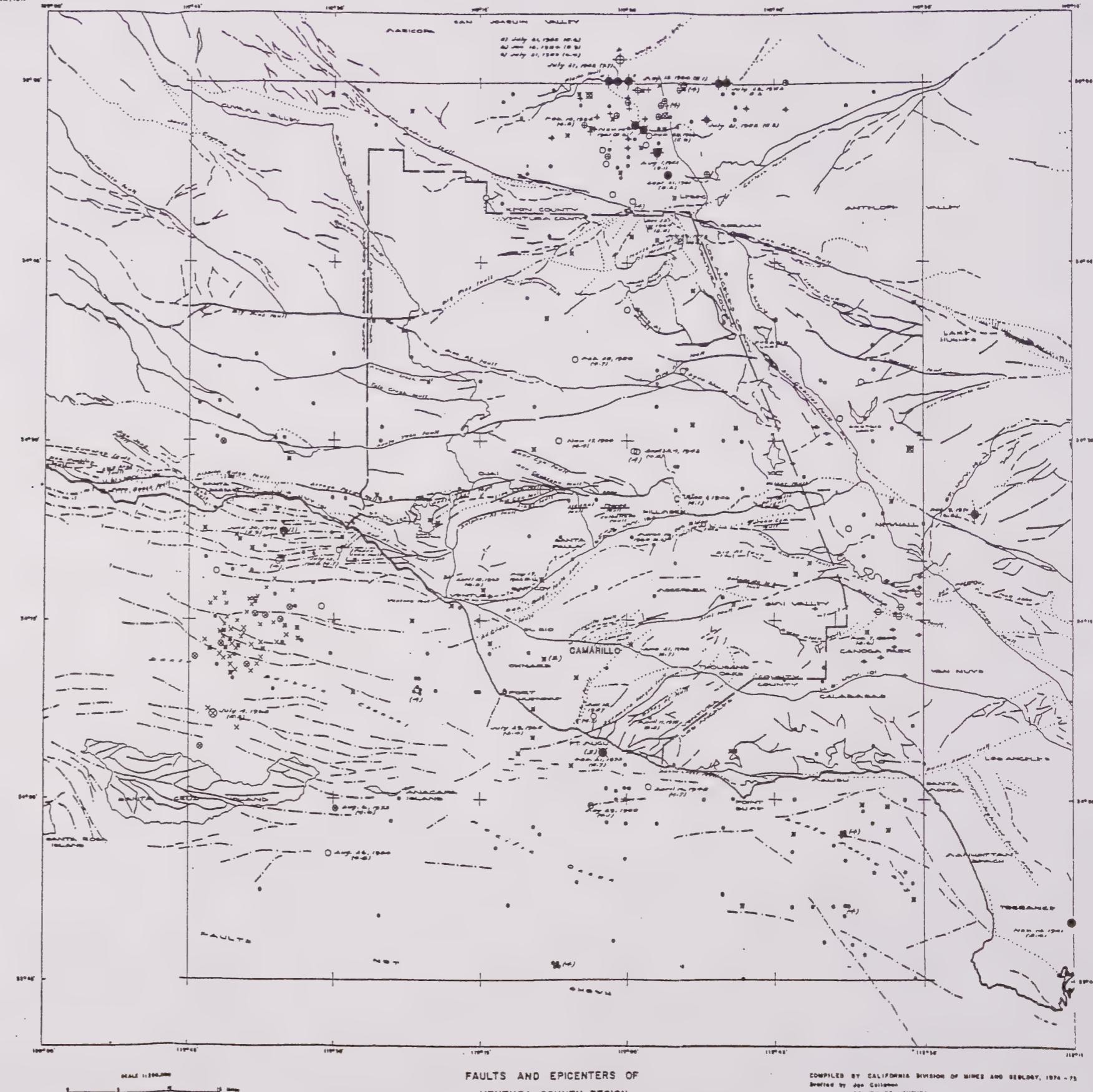
Magnitude	General Symbols <sup>(b)</sup>			James Gardner Catalog period 1900-1960	San Fernando catalogue of Feb. 9, 1971 and afterwards to Aug. 8, 1971
	1932-June 1961	July 1961-May 1, 1973	July 21, 1952 and afterwards		
3-4	•	■	+	+	×
4-5	○	■	●	●	○
5+	●	■	◆	◆	●

(a) Compiled mostly from Hittman and others (1973); Seismological Laboratory, California Institute of Technology; and from R. E. Shabot, California Division of Mines and Geology (1973); and U.S. Geological Survey

(b) Earlier locations are least accurate; from July 1961 onwards are located by Hittman and others to nearest 0.1 degree. (See Hittman and others, p. 1-8, 12-13.)

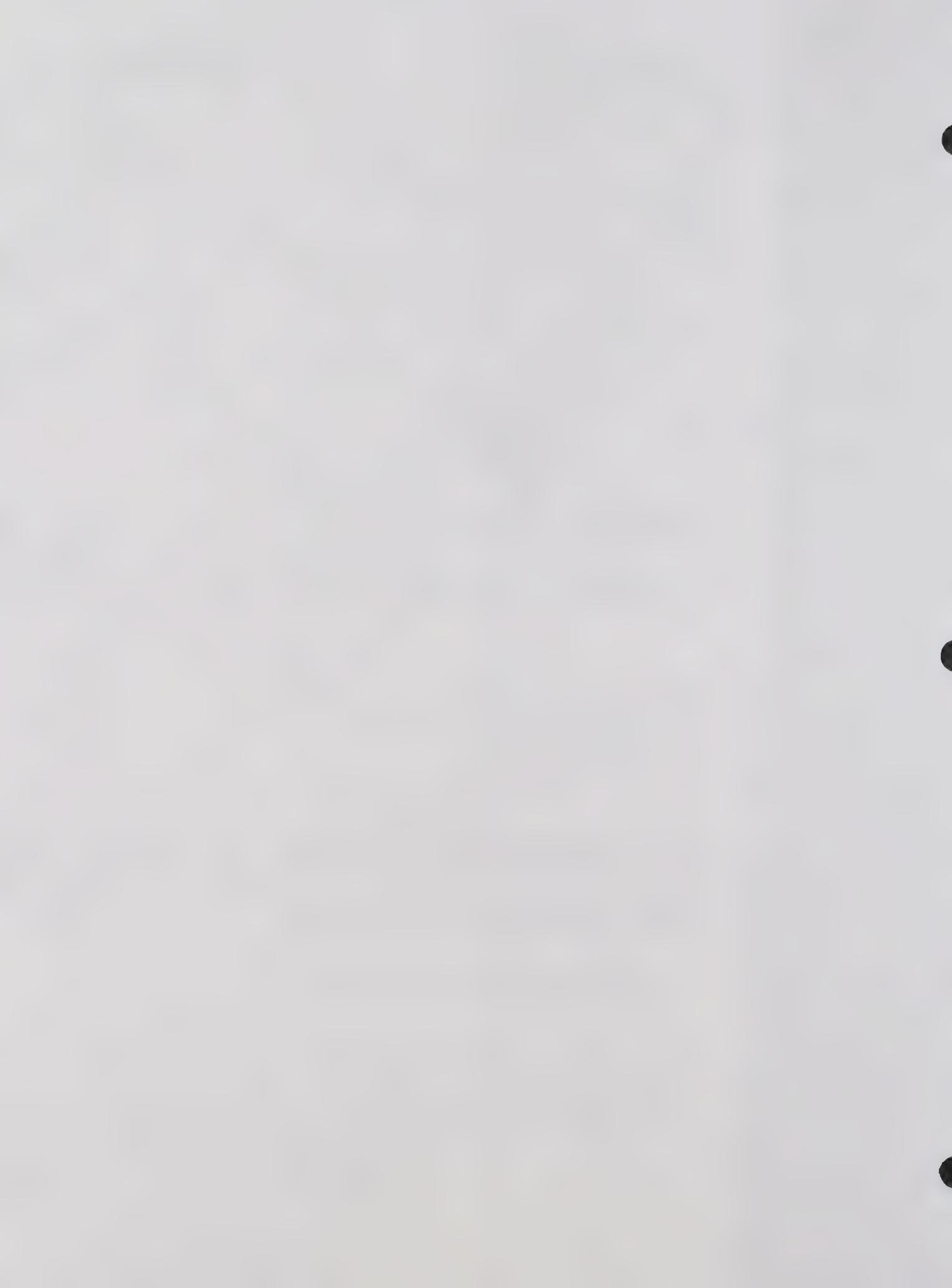
MAP  
All epicenters of Magnitude 2 or above are located within lower three, and those of Magnitude 3 and above within lower two.  
(1) Location for June 19, 1941 includes generally 69 aftershocks of Magnitude 3 and above.  
(2) Magnitude 3.9  
(3) Afternoon locations not included.  
(4) Epicenters of some coordinates are "rounded" in order to show total number of that location.

Effect of zone coding (percentage in Ventura County is given in parentheses) of this report:



FAULTS AND EPICENTERS OF  
VENTURA COUNTY REGION  
CALIFORNIA

COMPILED BY CALIFORNIA DIVISION OF MINES AND GEOLOGY, 1974-75  
DRAWN BY JAY CALIFORNIA  
COUNTY OF VENTURA  
ENVIRONMENTAL RESOURCE AGENCY  
PLANNING DIVISION



## RESOURCES AFFECTED BY THE POTENTIAL HAZARD

According to the Reconnaissance Geohazards Assessment Maps, the City of Camarillo is subject to seismic activity. Located within this area are schools, Pleasant Valley Hospital, portions of the Ventura Freeway, and Southern Pacific Railroad tracks. Also located in the city area are numerous residential developments and shopping centers.

On the basis of present information, it cannot be concluded that any of the structures or facilities are unsafe. However, the investigation of many critical or vital structures probably would show that the degree of structural resistance to shaking might be less than desirable, particularly for older structures.

## MANAGEMENT RESPONSIBILITY

### INVESTIGATION

Individual site investigations to provide detailed estimates of ground shaking sufficient for design purposes would include determination and analysis of the following information:

1. Depth and character of earth materials.
2. Presence of and depth to groundwater.
3. Depth to and character of bedrock.
4. Evaluation of past earthquake data.
5. Deterministic estimates of the most likely earthquake to occur within the life of the proposed structure based upon existing earthquake data and evaluation of the potential activity of nearby as well as distant fault sources.
6. Probabilistic evaluation of earthquake ground motions.

### WARNING

At the present time, prediction to any degree of accuracy earthquakes or severity or kind of ground shaking during earthquakes is not possible.

Although developing technology may someday enable earthquakes to be predicted, the potential availability of such information may have undesirable side effects. Those side effects include drastic and sudden variations of land values, insurance rates, and business; and disruptive impacts caused by the possible large, rapid migrations of the populace out of impacted areas.

### ALLEVIATION

Alleviation of existing hazards can be effected by replacement or strengthening of structures that may not be designed to resist strong ground shaking or modification of land uses as hazardous structures are removed. Determination of whether structures are hazardous would

require detailed geologic-seismic and soils engineering investigation of seismic and foundation conditions, and structural engineering evaluation of the particular structure.

## FINDINGS

### PROBABILITY OF OCCURRENCE

Available geologic information indicates that the potential for the occurrence of strong ground shaking over much of the county, as a result of an earthquake along one of the major faults, is high when compared to the statewide potential. Exactly where, when and how strong the next earthquake will be, however, cannot be determined.

### SEVERITY OF THE HAZARD

In the event of a strong earthquake (magnitude 6.0 to 7.5) originating in the southern county area or a major earthquake (8.0+ magnitude) along the San Andreas Fault, damage to many existing structures could be severe and some loss of life could occur.

The city is located largely in Zones B and C, which could experience moderate amplification of long-period ground vibration and greatest amplification of short-period ground vibration. Therefore, low-rise buildings, which have short natural vibration periods, could be more susceptible to damage in this area. This is based on the depth of alluvium and presence of broken bedrock underlying the area.

### RESOURCES AFFECTED

The greater portion of residential Camarillo is located within Zone B, including several schools and a hospital. In the center of this area is an area defined as Zone C in which the central city is located. Zone C also includes residences at the foot of the Camarillo hills.

### NATURE OF INFORMATION

The conclusions provided by this study are based primarily upon historical experience and the considerable scientific research that has been reported. Much of the information has been obtained since the occurrence of the 1971 San Fernando and 1994 Northridge earthquakes.

The hazard boundaries, as well as ground responses indicated by the Geohazards Map are at best conjectural. The information is only illustrative of the wide range of ground shaking that can be anticipated over relatively short distances based upon the type and depth of earth materials and presence of groundwater. Other factors that must be evaluated in determination of potential ground response include density of earth material, location, magnitude and depth of the earthquake, type of bedrock, and type of faulting causing the earthquake. Determination of these factors, and only within certain limits, requires detailed investigation of an individual site.

Technical studies that have resulted from the City's adoption of the

Guidelines for Geotechnical and Geologic Reports expanded the City's knowledge of geologic hazards in Camarillo. The results of those studies were largely responsible for the designation of Alquist-Priolo Earthquake Fault Zones in the Camarillo area by the California Division of Mines and Geology. Zone boundaries shown on the Alquist-Priolo maps and the City's Geohazards Maps must be considered approximate and subject to change as more detailed information becomes available.

## RECOMMENDATIONS

1. Encourage continued regional studies by qualified Federal and State agencies such as the U. S. Geological Survey and the State Division of Mines and Geology or private research firms in order to more accurately determine areas of potential hazardous ground shaking.
2. Encourage and participate in cooperative studies with adjoining cities and the County of Ventura.
3. Continue to adopt the most recent Uniform Building Code.
4. Qualified personnel registered and certified by the State should review reports and plans for land development.
5. Require geologic-seismic investigation for all projects including residential developments, multi-story buildings, industrial installations, buildings of a semi-public or public nature, large commercial buildings, large utility and storage facilities, and major utility lines proposed anywhere within the city.
6. Encourage structural evaluation of all existing public buildings and buildings used for public assembly, to ensure conformance to current Uniform Building Code requirements in regard to resistance to ground shaking.
7. Require the design of buildings, major utilities, and other facilities, which need to remain operable after an earthquake, be built or retrofitted to resist strong ground shaking forces.
8. Encourage the installation of auxiliary equipment, facilities and machinery which must remain operable after an earthquake to resist ground shaking effects.
9. Evaluate disaster plan demands and potential effectiveness in terms of various earthquake intensities. Create countywide systematic review by emergency preparedness organizations, fire departments, and police departments on contingency disaster plans and programs.
10. Evaluate existing major public utility systems in terms of susceptibility and acceptable risk of ground shaking.

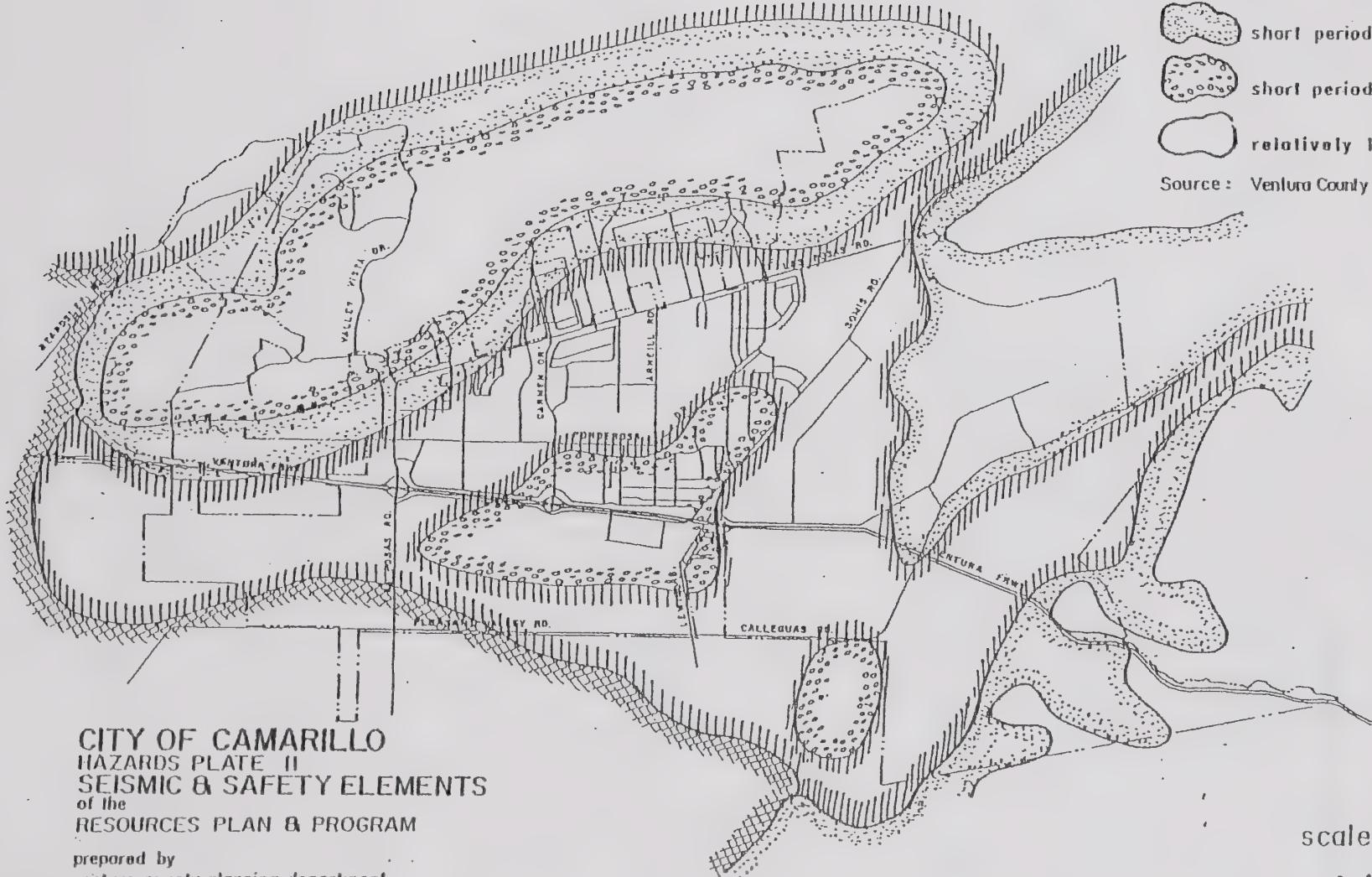
## FLOODING

### GENERAL DISCUSSION

A flood may be defined as a "temporary rise in stream flow or stage that results in water overtopping its banks and inundating areas adjacent to the channel." (Kusler, p. 54). The area subject to inundation is generally referred to as the flood plain.

The size and frequency of occurrence of a flood in a particular channel depends on a complex combination of conditions, including the amount, intensity and distribution of rainfall, previous moisture condition and drainage patterns.

The magnitude of a flood is measured in terms of its peak discharge, which is the maximum volume of water (in cubic feet per second) passing a point along a channel. However, floods are usually referred to in terms of their frequency of occurrence, which is related to discharge; for example, the 100-year flood for a particular channel is the size flood which has a probability of being equaled or exceeded once in 100 years. The magnitude of the flood selected by a governmental agency for planning purposes (usually 50-year or 100-year) is referred to as the selected or regulatory flood.



Flooding is a natural occurrence, with some long range beneficial aspects such as replenishment of sand to beaches and of nutrients to agricultural lands. It is a hazard only because people find flood plains a desirable place to live and use. Man's encroachment of flood plains can also increase the hazard; structures may obstruct the flood flow, thus increasing flood heights, and the covering of the ground with impervious surfaces (e.g. pavement) increases the rate and quantity of runoff.

## GENERAL EFFECTS OF THE HAZARD

The primary effect of flooding is the threat to life and property. People and animals may drown; structures and their contents may be washed away or destroyed; roads, bridges, and railroad tracks may be washed out; and crops may be destroyed.

Much of the property damage from floods is caused by the severe erosion which results from fast-moving flood waters. Serious damage can also be caused by the floating debris and sediment carried by flood waters. Floating debris (including parts of buildings, trees, etc.) can obstruct the flood flow, resulting in increased flood heights and overflow areas. Debris can also damage structures and bridges, and can damage or plug flood control channels. Mineral and organic debris and sediment deposited on the land as the flood waters recede create a huge cleanup problem and health hazard and can destroy crops and croplands.

Floods may also create health hazards due to the discharge of raw sewage from damaged septic tank leach fields, sewer lines, and sewage treatment plants and due to flammable, explosive, or toxic materials carried off by flood waters. In addition, vital public services may be disrupted.

A major secondary effect of flooding is the cost to local and national taxpayers. Evacuation, relief and flood-fighting services, cleanup operations, and the repair of damaged public facilities are all paid for by the public. Taxpayers must also bear a share of the cost of federal loans for reconstruction of private property and of damage claims under federally subsidized flood insurance. Another large expense arises from the construction and maintenance of flood control facilities to protect development from future floods.

## GENERAL INVENTORY OF THE HAZARD

The largest and most damaging recorded natural floods in the Calleguas Creek, Santa Clara, and Ventura watersheds occurred in 1969. (The St. Francis Dam failure in 1923 caused the largest known flood on the Santa Clara River). In 1969, the 50- and 100-year peak discharges were exceeded in many channels. The combined effects of the 1969 floods were disastrous: thirteen people lost their lives and property damage was estimated at 60 million dollars. Homes in Casitas Springs, Live Oak Acres, and Fillmore were flooded and 3,000 residents in Santa Paula and several families in Fillmore were evacuated twice. A break in the Santa Clara levee threatened the City of Oxnard. Much agricultural land, primarily citrus groves, was seriously damaged. All over the County, transportation facilities,

including roads, bridges and railroad tracks were damaged. There was several million dollars worth of damage at the Ventura Marina. The Fillmore, Oak View and Ventura sewage treatment plants were severely damaged, dumping raw sewage into the Santa Clara and Ventura rivers and polluting beaches. In addition, sewer trunk lines were broken along San Antonio Creek, Ventura River and Calleguas Creek.

## DEFINITION OF HAZARD ZONE

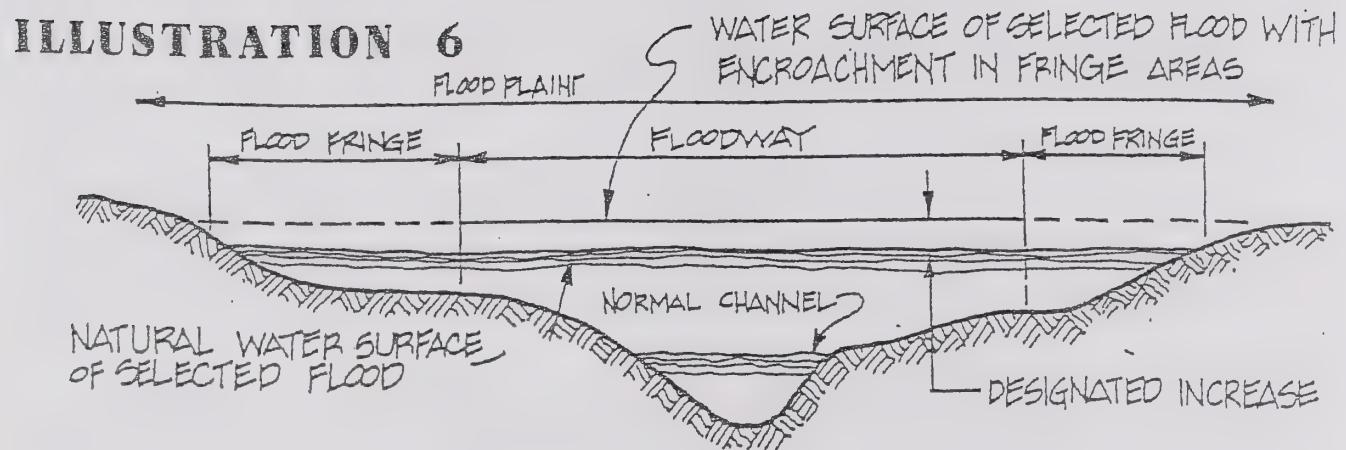
The boundaries of the hazard zone depend on the magnitude of peak discharge chosen for the selected flood. The Ventura County Flood Control District and most of the cities in the County use a 50-year flood as the selected flood, while the National Flood Insurance Regulations, the City of Camarillo, and most flood plain management literature use a 100-year flood.

The Ventura County Flood Control District uses a dual standard in regard to the containment of a 50-year flood with freeboard and containment of a flood ignoring freeboard. In reviewing the areas subject to flooding, the Flood Control District and City utilize the Flood Insurance Rate Maps and Floodway Maps issued by the Federal Emergency Management Agency (See FEMA Maps Plate III).

The flood plain may actually be divided into two hazard area: (1) the floodway, which is the portion that carries the deep and fast-moving water (usually defined as the area needed to contain the flood, allowing for a designation increase in flood height); and (2) the flood fringe area, which is the remainder of the flood plain.

## NATURE OF INFORMATION

Flood plain limits are calculated from the best topographical information and hydrologic and hydraulic data and assumptions available. These delineations reflect existing conditions and changes in topography or land uses could affect these limits. Although the flood plains of many of the watercourses in the County have not been mapped, the Flood Control District has the capability to calculate the overflow areas for specific locations.



Floodway limits, which are extremely important for flood plain planning, have not yet been delineated for any channels in the County. However, the Flood Control District has begun a 5-year program of mapping flood plains and will soon begin to compute floodway limits (referred to as "designated watercourses") for the rivers and major tributaries. The computation and designation of floodways for all channels under the District's jurisdiction will take many years.

## LOCAL DISCUSSION

### LOCAL INVENTORY OF THE HAZARD

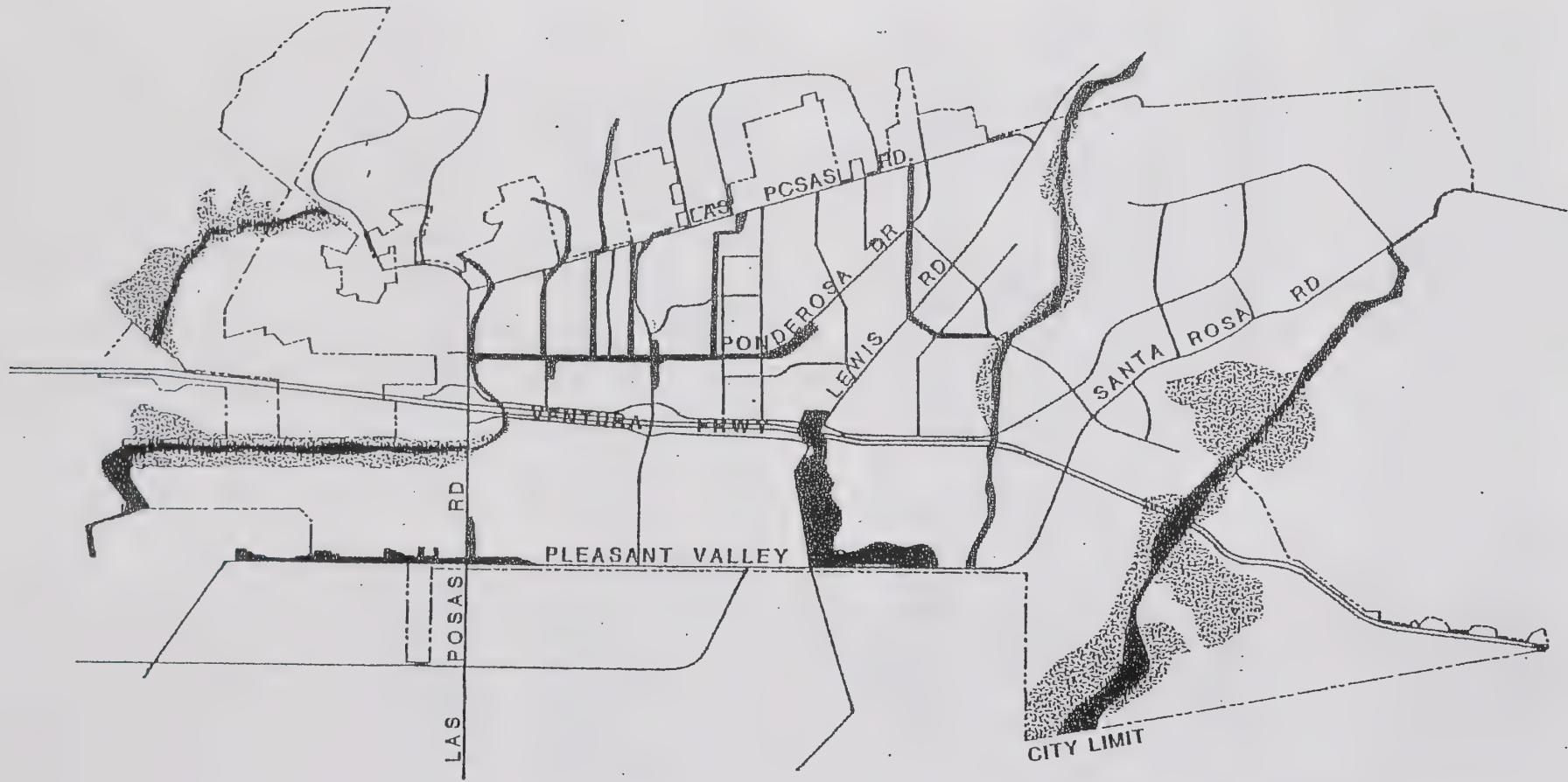
Calleguas Creek and its tributary, Conejo Creek, both penetrate eastern Camarillo and Revolon Slough is located to the west of the City. (see Hazard Plate III) The Revolon Slough flood plain limits are only available for the 50-year flood. Revolon Slough south of the freeway is a fully improved channel from Mugu Lagoon to the Ventura Freeway. Beardsley Wash, north of the freeway, is improved part way to Central Avenue.

Drainage channels are also indicated on Plate III. Although extensive channel improvements have been constructed within the City, flooding problems remain unresolved generally north of Las Posas Road and east of Somis Road.

### RESOURCES AFFECTED BY THE HAZARD

Camarillo designs its streets and development to be reasonably free from any 50-year flood projection and any building pad within the flood plain must be free of the 100-year flood plain level. Presently, the flood plain limits in Camarillo are mostly in agriculture but include a few residential and industrial uses and portions of Highway 101 and the Southern Pacific Railroad tracks. Developments can be expected to be reasonably protected from flooding because of the City's regulations. Those areas which have been "flood-proofed" are designated as such on the Hazard Plate at Camarillo.

Further development within the Revolon Slough watershed may jeopardize the flood control plans for agricultural development. Major storm flows in Revolon Slough now exceed the safe flood level based on the historically inadequate capacity of the existing channel.



NOTE: THIS MAP HAS BEEN  
SUBMITTED TO F.E.M.A.  
FOR FINAL APPROVAL  
AND WILL BECOME PART  
OF THIS PLAN  
PENDING ADOPTION.



**50 YEAR FLOOD BOUNDARY**



**100 YEAR FLOOD BOUNDARY**

**DESIGNATED FLOOD PLAINS**  
**CITY OF CAMARILLO DEPARTMENT OF PLANNING AND COMMUNITY DEVELOPMENT**

## MANAGEMENT RESPONSIBILITY

### INVESTIGATION

The Federal Emergency Management Agency (FEMA) has prepared Flood Insurance Rate Maps and Floodway Maps that delineate the areas subject to flooding. The maps rate areas as subject to minimal flooding (Flood Zone C), areas between limits of a 100-year flood and 500-year flood (Flood Zone B), or areas of 100-year flood (Flood Zone A).

### REGULATION

The entities responsible for regulation in flood hazard areas are the local governments and the Ventura County Flood Control District, which is governed by the Board of Supervisors, has the authority to maintain and construct flood control facilities on the channels shown on Hazard Plate III. Ordinance FC-18, adopted in 1972, requires that a permit from the Flood Control District be obtained for most activities in floodways.

Outside of the designated watercourses, the prime responsibility for regulating activities in flood hazard areas lies with local governments. By state law, land use and building restrictions to protect life and property from floods may be included in zoning and subdivision ordinances and building and sanitation codes. The City of Camarillo in 1987 adopted a Flood Plain Ordinance, which identifies standards for development in flood hazard areas.

The Colbey-Alquist Flood Plain Management Act requires regulation as a condition for State assistance on federally authorized flood control projects.

The regulations of the National Flood Insurance Program (administered by the Department of Housing and Urban Development) require that communities adopt land use restrictions normally for the 100-year flood plain, in order to qualify for federally-subsidized flood insurance. The types of restrictions communities must adopt are listed in some detail in the regulations; included is a requirement that residential structures be elevated above the level of the 100-year flood. Participation in the flood insurance program was recently made virtually mandatory by an amendment making flood insurance (in identified "special flood hazard" areas) a prerequisite for receiving mortgages or construction loans from federally-regulated lending institutions.

### WARNING

Flood warnings, issued by the U. S. Weather Bureau or the Flood control District, are relayed to the public through the local news media and Sheriff's and Police Departments.

## ALLEVIATION

The flood hazard may be alleviated through a variety of measures, some corrective and some preventive.

Corrective measures include warning and relief programs, flood proofing of existing structures, and the construction of flood control works (channel improvements, levees and dams). Structural works are the traditional means of alleviating the hazard, but they are extremely costly and are rarely able to keep up with development.

Nationally, a half billion dollars a year is spent on flood control works, while flood damages average one billion dollars a year and are increasing. (Kusler, p. 3 and Sierra Club, p. 59). The cost of structurally protecting all the channels in the County Flood Control District's comprehensive plan has been estimated at over 300 million dollars, (V.C.F.C.D., the Great Floods of 1969, p. 2). Improperly planned structural works may also have the effect of increasing downstream flood peaks and velocities and may contribute to beach erosion by reducing the amount of sand reaching the beaches. (Norris, R.M., p 154)

Preventive measures for alleviating the hazard include public acquisition of flood plain lands, public information program, development policies and regulations. The most effective means of preventing flood damage appears to be the regulation of the types of activities permitted in flood hazard areas. This approach is generally referred to as flood plain management. Flood plain management addresses the problems encountered in the utilization of flood plains; given the possible future land uses, the total spectrum of possible solutions to problems considered. Flood plain management, however, cannot protect all existing development. Therefore, to provide for the maximum alleviation of the flood hazard, a combination of corrective and preventive measures is necessary.

## FINDINGS

### PROBABILITY OF OCCURRENCE

Floods are natural occurrences whose frequency and magnitude depend on the rainfall and drainage patterns. It can be expected that the flood plain will probably be completely inundated on the average of once every 100 years.

### SEVERITY OF THE HAZARD

The portions of Camarillo that are subject to flooding from the indicated streams are primarily undeveloped and, therefore, could easily be protected through flood plain management. Existing structures are required to be reasonably free from any 50-year flood projection and any building pad within the flood plain must be elevated above the 100-year flood plain level.

## RESOURCES AFFECTED

Existing uses in the hazard areas are largely agricultural or vacant with a few residential and industrial areas. Sections of Highway 101 and the Southern Pacific Railroad tracks are affected by the hazard zone.

## NATURE OF INFORMATION

Existing data are sufficient to calculate the overflow for specific areas. In addition, the 1986 Flood Emergency Management Agency Maps prepared for the National Flood Insurance Program has provided base information regarding watercourses and flood areas.

## FLOOD HAZARD

The City Council in 1986 adopted the Flood Hazard Ordinance to address the potential flood hazard areas in Camarillo and to identify measures to minimize or reduce the impacts. The flood hazard areas of Camarillo are subject to periodic inundation which might result in loss of life and property, health and safety hazards, disruptions of governmental services and road access, along with entailing governmental expenses in correcting the emergency situations.

## RECOMMENDATIONS

1. Designate undeveloped flood plains as open space or agricultural land uses on the General Plan.
2. Adopt the 100-year flood map as the "selected flood" for flood plain regulation with the map to be periodically updated.

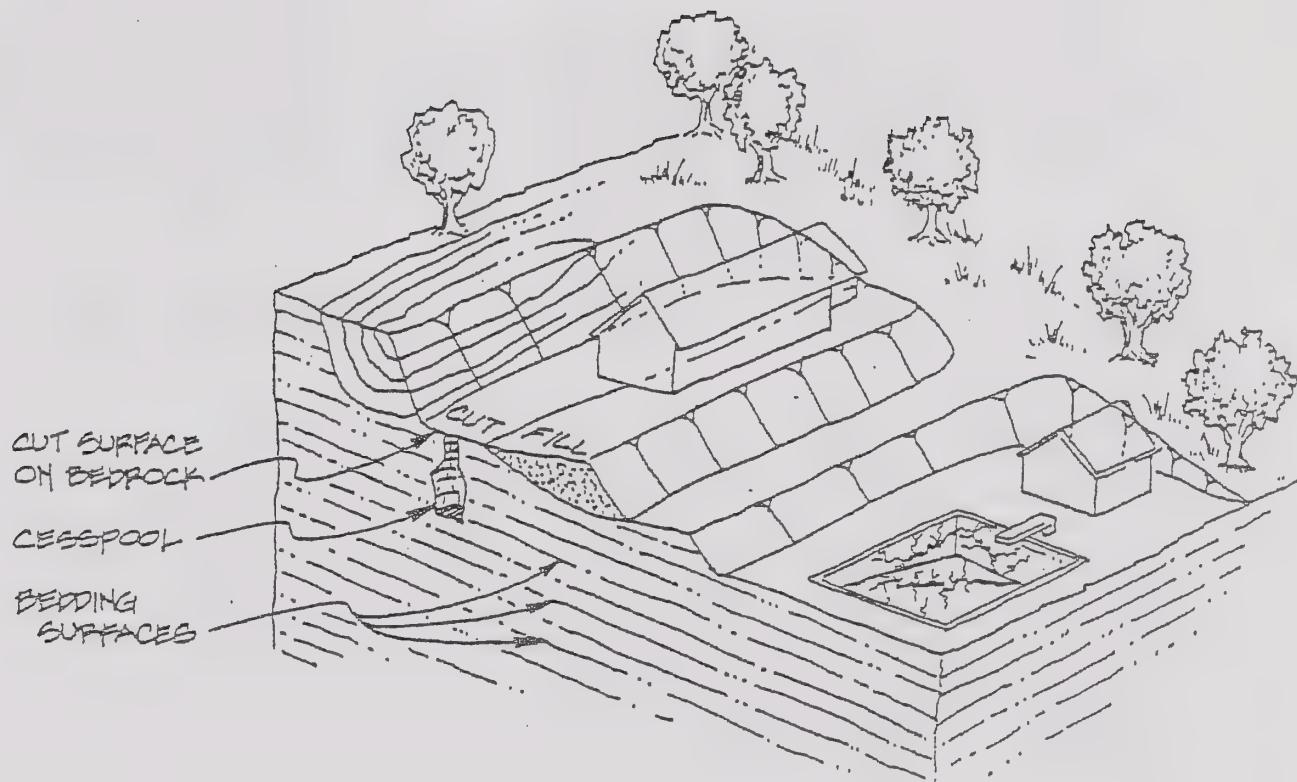
The flood plain regulations require different measures depending on the amount of information available. When the administrator has identified the flood plain area having special flood hazards, and has provided water surface elevations for the 100-year flood, but has not provided data sufficient to identify the floodway or coastal high hazard area, the minimum land use and control measure adopted by the community for the flood plain must:

- (a) Meet the following requirements:
  - (1) Take into account flood plain management programs, if any, already in effect in neighboring areas;
  - (2) Apply at a minimum to all areas identified by the administrator as flood plain areas having special flood hazards;
  - (3) Provide that within the flood plain area having special flood hazards, the laws and ordinances concerning land use and control and other measures designed to reduce flood losses shall take precedence over any conflicting laws, ordinances, or codes;
  - (4) Require building permits for all proposed

construction or other improvements in the flood plain area having special flood hazards;

- (5) Review building permit applications for major repairs within the flood plain area having special flood hazards to determine that the proposed repair first, uses construction materials and utility equipment that are resistant to flood damage, and second, uses construction methods and practices that will minimize flood damage;
- (6) Review building permit applications for new construction or substantial improvements within the flood plain area having special flood hazards to assure that the proposed construction (including prefabricated and mobile homes) first, is protected against flood damage; second, is designed (or modified) and anchored to prevent flotation, collapse or lateral movement of the structure; third, uses construction materials and utility equipment that are resistant to flood damage; and, fourth, uses construction methods and practices that will minimize flood damage;
- (7) Review subdivision proposals and other proposed new developments to assure that first, all such proposals are consistent with the need to minimize flood damage; second, all public utilities and facilities, such as sewer, gas, electrical and water systems are located elevated and constructed to minimize or eliminate flood damage; and, third, adequate drainage is provided so as to reduce exposure to flood hazards; and
- (8) Require new replacement water supply systems and/or sanitary sewage systems to be designed to minimize or eliminate infiltration of flood waters into the systems and discharge from the systems into the flood waters, and require on-site waste disposal systems to be located so as to avoid impairment of them or contamination from them during flooding.

ILLUSTRATION 7



DEVELOPMENT OF MAN-MADE BEDROCK LANDSLIDES (modified from R.H. Jahns).

Hundreds of landslides in southern California are traceable to this general situation. This problem, as much as any other, has led to the adoption of grading ordinances. A naturally stable "dip-slope" has been made unstable by removing the support from bedding planes which resemble the surfaces between a tilted deck of cards. The cracking shown is one of the early signs that a landslide is imminent. Irrigation and sewage effluent contribute to slippage along the bedding.

(b) Require new construction or substantial improvements of residential structures within the area of special flood

hazards to have the lowest floor (including basement) elevated to or above the level of the 100-year flood;

- (c) Require new construction or substantial improvements of non-residential structures within the area of special flood hazards to have the lowest floor (including basement) elevated to or above the level of the 100-year flood or, together with attendant utility and sanitary facilities, to be flood-proofed up to the level of the 100-year flood; and
- (d) In riverine situations, provide that until a floodway has been designated, no use, including land fill, may be permitted within the flood plain area having special flood hazards unless the applicant for the land use has demonstrated that the proposed use, when combined with all other existing and anticipated uses, will not increase the water surface elevation of the 100-year flood more than one foot at any point.

3. Require that a mention of the flood hazard be included on all deeds of sale for property subject to flooding of a 100-year storm.
4. Adopt a policy to discourage the construction of public facilities in flood plain areas, unless such facilities are designed to be floodproofed from a 100-year storm.
5. Encourage the construction of major flood control projects by the appropriate agency to protect existing developments.

## LANDSLIDE & MUDSLIDE

### GENERAL DISCUSSION

All hills, mountains, and other highlands are being worn down by various natural processes. The most spectacular of these is the landslide, along with the other related types of ground failure. These processes are referred to geologically as "mass wasting," defined as: "the en masse downslope movement of rock debris" (Physical Geology, p. 134). There are numerous causes for mass wasting, including erosion, water, broken or weak bedrock, earthquakes and engineering defects.

Stream erosion can undercut slopes thereby removing support and causing failure of slopes by landsliding.

Saturation of soil or bedrock on hillsides can reduce the strength of these materials under certain conditions to a point where downhill sliding can occur in response to gravity. Rainfall can also saturate and erode vast quantities of loose soil, especially after large fires denude slopes, washing it down slope to slides (see Liquefaction Hazard).

Finally, man-made cuts or excavations can undercut unstable slopes, thus causing landslides. In practice, most landslides are caused by a combination of two or more of these factors, and come in a number

of forms.

In general, most landslides within the County are shallow, ranging up to perhaps 100 feet in depth and limited in extent, generally less than 100 acres. Most are not presently in motion (active) but have moved downslope to positions of stability.

Generally, stability is achieved within several years after the initial failure under natural conditions. However, the margin of stability of most landslides is small and inadequate to safely place structures on their surfaces.

Many of the existing landslides can be reactivated and downslope movement renewed after exceptionally heavy rainfall periods or as a result of earthquake shaking. Most landslides are over 100 years old and can exist for thousands of years until all of the landslide material is removed from the hillside by erosion.

Generally, the renewed movement of old landslides is slow, perhaps only a few inches per day. However, the formation of a new landslide can be rapid with initial, often quite sudden movements of hundreds of feet within a few hours.

Hundreds of landslides in southern California are traceable to the general bedrock situation shown on Illustration 1. As long as the original natural slope remained ungraded, it was stable because bedding surfaces were essentially parallel to the ground surface and were supported at the lower end. Once the slopes were cut, though, support was removed from the bedding surfaces.

The fill in the upper residential lot of Illustration 7 is uncontrolled and, therefore, is probably poorly compacted. In this state, it can settle, erode and slough without sliding en masse. Settlement can crack the foundations and walls, because the portion of the house on bedrock will not settle as much as the portion on fill.

A cut slope in which support has been removed can fail immediately upon being excavated; or it can continue to stand for a number of years. They are the principal slopes that give way one by one during succeeding wet seasons; their ultimate failure is inevitable. The cracking illustrated in Illustration 7 is one of the early signs that a landslide is eminent. As the cracks widen, they can serve as channelways for surface runoff, which facilitates mass movement.

## GENERAL INVENTORY OF THE HAZARD

### LOCATION & HISTORY

#### SOUTHERN VENTURA COUNTY

In general, the highest propensity for landsliding is found along the more prominent fault zones, anticlinal folds and in areas of the younger geologic formations. Landslides and potentially unstable slopes are especially common in hillslide areas underlain by sedimentary bedrock of the Pico, Saugus, Santa Barbara, Monterey/Modelo and Rincon Formations. Those formations are generally uncemented (soft) and contain abundant silt and clay strata. The presence of subsurface water is also a contributing factor to slope instability in the great majority of landslide occurrences.

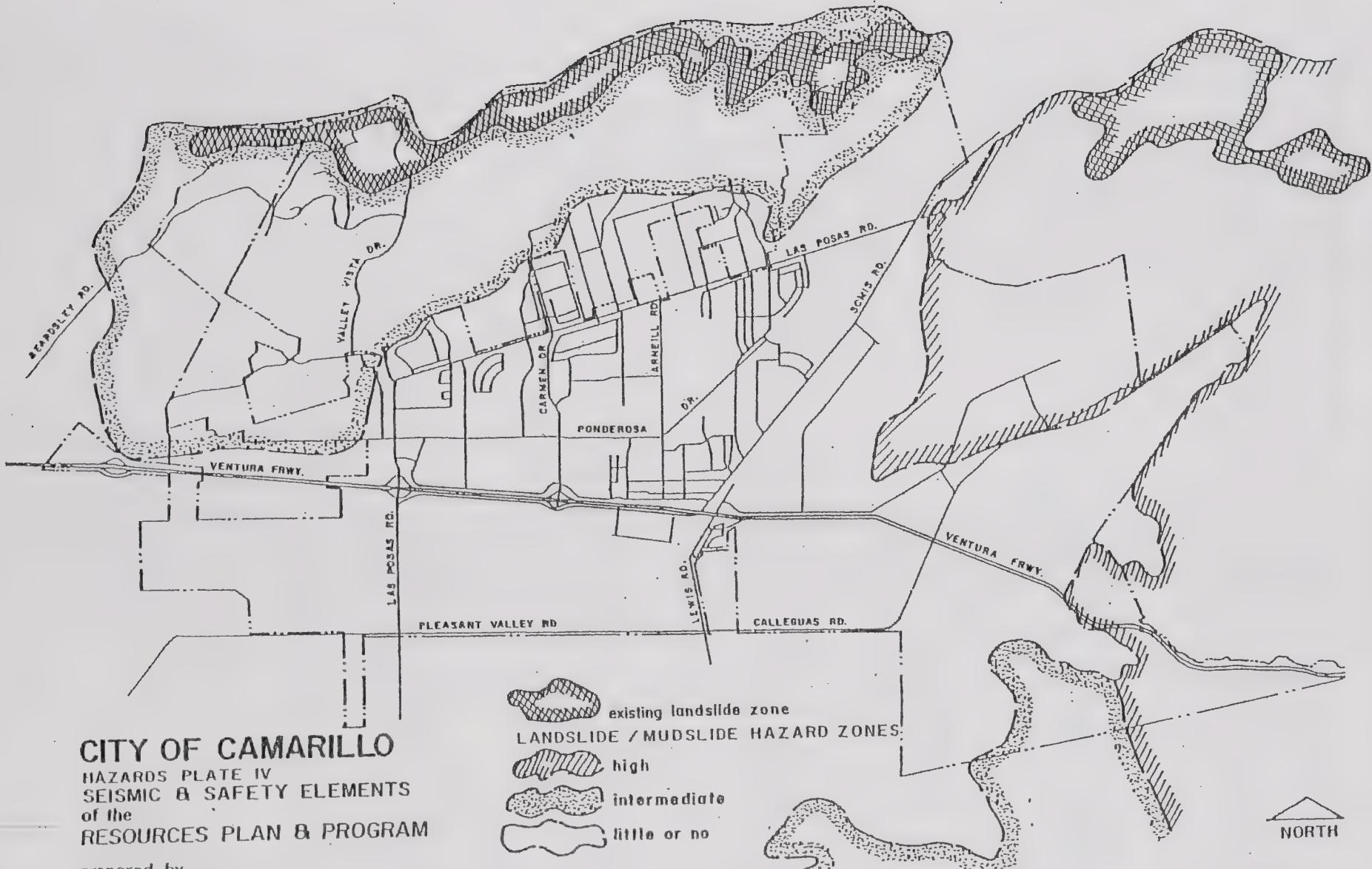
Landslides and slope instability are widespread throughout the hillside areas. In general, most existing landslides are within the Existing Landslide Areas shown on Hazard Plate IV; most are not of recent origin, having occurred over 100 years ago, and most are not actively moving. However, they are subject to potential renewal movement if triggered by poorly planned grading, earthquakes, or if the ground moisture is increased. The areas of landsliding are, in general, confined to the areas of weak or clay bedrock and adverse geologic structure (such as bedding planes dipping in downslope direction).

### LOCAL DISCUSSION

#### LOCAL INVENTORY OF THE HAZARD

Portions of the southern, eastern and western margins of the Camarillo Hills and the southwestern Santa Rosa Hills are present within the City. A few significant landslides are known to exist within those areas, and many slopes are only marginally stable. As in most other hilly terrain, landsliding can be caused by the activities of man, unless stability considerations are incorporated in the design of development.

The level of hazard in the hillside areas of the city is shown on Hazards Plate IV and designated as High Landslide/Mudslide Hazard Areas.



scale 0 2000 400

october 1974

## RESOURCES AFFECTED BY THE HAZARD

Comparison of Hazard Plate IV with present land uses within the City indicates that primarily only residential structures are within the hazard zone. Although some commercial developments are proposed in the zone, none of the existing development is known to be in immediate danger from landsliding. However, detailed information on individual structures was not evaluated during this study.

## HAZARD ZONES

The Hazard Zone boundaries were primarily determined based on information provided by two studies of landslide conditions in southern Ventura County (conducted by the State Division of Mines and Geology for the Federal Department of Housing and Urban Development (HUD) and for the County of Ventura under a cooperative agreement).

The product of the latter study was the report entitled "Geology and Mineral Resources Study of Southern Ventura County" (1973), Preliminary Report 14.

The current cooperative GEOLOGIC HAZARDS INVESTIGATION being conducted by the State Division of Mines and Geology for the Ventura County area will provide additional necessary information on landslide hazards in regard to areas of the southern half of the County which could be susceptible to low-angle or lateral spreading during earthquake shaking. Except for the additional information being generated by the State, the present information is the best form available and is considered adequate for general planning purposes. It will, however, need to be supplemented with more detailed mapping or studies for any specific proposed development.

Camarillo presently contracts with a private geologic and soils investigation firm for the review of public and private projects. The proposed developments are reviewed prior to their approval by the Planning Commission or City Council or after the preparation of detailed site specific studies of the geotechnical concerns.

## WARNING

The potential for landsliding can be detected with relative certainty before any structures or facilities are placed in jeopardy. However, the problem is more difficult to handle in those hillside areas where development has already occurred in possibly dangerous locations. In cases where structures have been constructed, regional studies can, in many places, delineate potential problem areas before damaging movement occurs. The City's recently adopted Reconnaissance Geohazards Assessment identifies landslide areas within Camarillo.

Presently, little is known of the potential for low-angle landsliding resulting from liquefaction of sediments during earthquake shaking or of areas in which this hazard exists. As previously indicated, this hazard is being evaluated under the Cooperative Geologic Hazards Investigation being conducted by the State Divisions of Mines and Geology.

## FINDINGS

### PROBABILITY OF OCCURRENCE

The hillside areas of the City are presently being developed and areas having stability problems have been graded and reconstructed. Existing landslides are present in the westerly portions of the Camarillo Hills and as these areas develop, they will be reviewed to ensure that any landslides are graded and reconstructed.

### SEVERITY OF THE HAZARD

Most of the city is within the little or no hazard zone. Although, the hillside areas within which present development is occurring are in higher hazard zone.

### RESOURCES AFFECTED

Comparison of Hazard Plate IV with present land uses indicates that primarily only residential structures are present within the hazard zone and none are known to be in immediate danger from landsliding.

### NATURE OF INFORMATION

The present information is the best available and is considered adequate for general planning purposes. It will, however, need to be supplemented with more detailed mapping or studies for any specific proposed development.

### RECOMMENDATIONS

1. Require that any proposed development within the Existing Landslide Areas or areas of High or Intermediate Hazard indicated on Hazard Plate IV be shown to be feasible by completion of engineering geologic and soils engineering studies by qualified personnel, including recommendations for safe development, and be reviewed by a person qualified prior to approval of proposed land uses. Such studies should also be required, as necessary, in other areas.
2. Continue to adopt the Uniform Building Code and the additional provisions of the City's Subdivision Ordinance, Building Regulations, and the City's hillside and grading standards for all land development.
3. Continue to achieve adequate enforcement through qualified staff or retaining private consultants on an as-needed basis.

### LIQUEFACTION

### GENERAL DISCUSSION

In some earthquakes, ground shaking results in ground failure, which can have catastrophic effects on structures. Earthquake-induced ground failure on relatively level terrain can often be attributed to

liquefaction.

Liquefaction can occur when loose, cohesionless soils saturated with water are subjected to ground shaking of high enough intensity and long enough duration. Liquefaction is manifested either by the formation of sand boils and mudspouts at the ground surface and the seepage of water through ground cracks, or in some cases, by the development of quicksand-like conditions over substantial areas. When quicksand-like conditions occur, buildings may sink substantially or tilt into the ground, and lightweight buried facilities may float to the surface (Seed, 1969). Other manifestations are flow-landslides, which can move hundreds of feet, and lateral earth spreading of tens of feet. A common result of subsurface liquefaction is settlement of the overlying ground surface.

Loose, granular soil materials are most susceptible to liquefaction.

Uniformity of grain size, such as a deposit of only sand, causes materials to be more susceptible to liquefaction than well-graded materials, which consist of particles of many different sizes. The deeper the soil zone susceptible to liquefaction, the higher the confining pressure and the less the potential for liquefaction. Liquefaction that affects surface structures usually occurs within the upper 50 feet, but deeper liquefaction can occur.

Small-magnitude earthquakes do not trigger liquefaction, because several cycles of strong ground motion are needed to trigger liquefaction and small-magnitude earthquakes do not produce strong ground motion. Large earthquake events (typically above about magnitude 5.5) do produce strong ground motion cycles and the larger the magnitude the greater the number of cycles of strong ground motion generated. The number of cycles of strong ground motion needed to trigger liquefaction at a site depends on soil conditions.

The looser the soil, the more easily liquefaction is triggered. For example, liquefaction-related landslides of the 1964 Alaskan Earthquake did not occur until 90 seconds after shaking from a large earthquake, but in the 1971 San Fernando Valley Earthquake, liquefaction landslides were triggered after only 30 seconds of shaking from a moderate earthquake.

Because numerous active faults are present in the Ventura County region, the potential for liquefaction exists in Camarillo wherever there are saturated loose sand deposits, especially if they are near the surface.

## GENERAL EFFECTS OF THE HAZARD

### PRIMARY EFFECTS

Larger buildings not designed to withstand liquefaction can be severely affected by liquefaction at depth, even if the building is supported on deep pile foundations (if the liquefaction results in a loss of bearing capacity from the piles). Light subsurface structures such as pipelines and storage tanks embedded in liquefiable soil can float to the surface during the ground shaking, causing further damage and potentially widespread disruption of services.

If subsurface liquefaction occurs on sloping ground, the liquefied layer can act as a slip plane and allow the layers above it to slide downhill. That type of liquefaction is a common cause of earthquake-induced lateral-spreading flow landslides. Structures built across the edges of those flow slides are torn apart in much the same manner as if they were located across the trace of a fault rupture. In the 1971 San Fernando earthquake, an area of almost 163 acres moved down a 2.5% slope on a liquefied subsurface layer causing damage of over \$30 million.

Liquefaction of subsurface layers on nearly level ground can cause ground oscillations to occur. In that situation, a nearly horizontal layer of soil liquefies at depth causing the near-surface soils above it to detach from the underlying layers and move differentially. That allows the surface of the ground to oscillate or lurch separate from the soil materials below the liquefied zone. Ground oscillations of that type occurred at several locations in Simi Valley during the 1994 Northridge earthquake, causing significant damage to surface structures in those areas.

### SECONDARY EFFECTS

Liquefaction could destroy or disrupt gas, water, sewer lines, and roads. Pipelines could be broken either by being floated to the surface or by lateral displacement. Bridge abutments could suffer differential settlement and lateral movements, cutting off roads.

## GENERAL INVENTORY OF THE HAZARD

### LOCATION

The hazard exists wherever there are susceptible soils, particularly loose, sandy soils that are constantly or seasonally saturated with water. This might include most of the river valleys and the low-lying plains areas that have poor drainage (Hazard Plate V). Subsurface soil properties are not well known in areas that have not been explored for development. Therefore, for planning purposes, all alluvial areas having high groundwater are typically assumed to be subject to liquefaction during strong earthquake shaking. Areas underlain by bedrock materials or areas where groundwater is deep typically are assumed to be non-liquefiable.

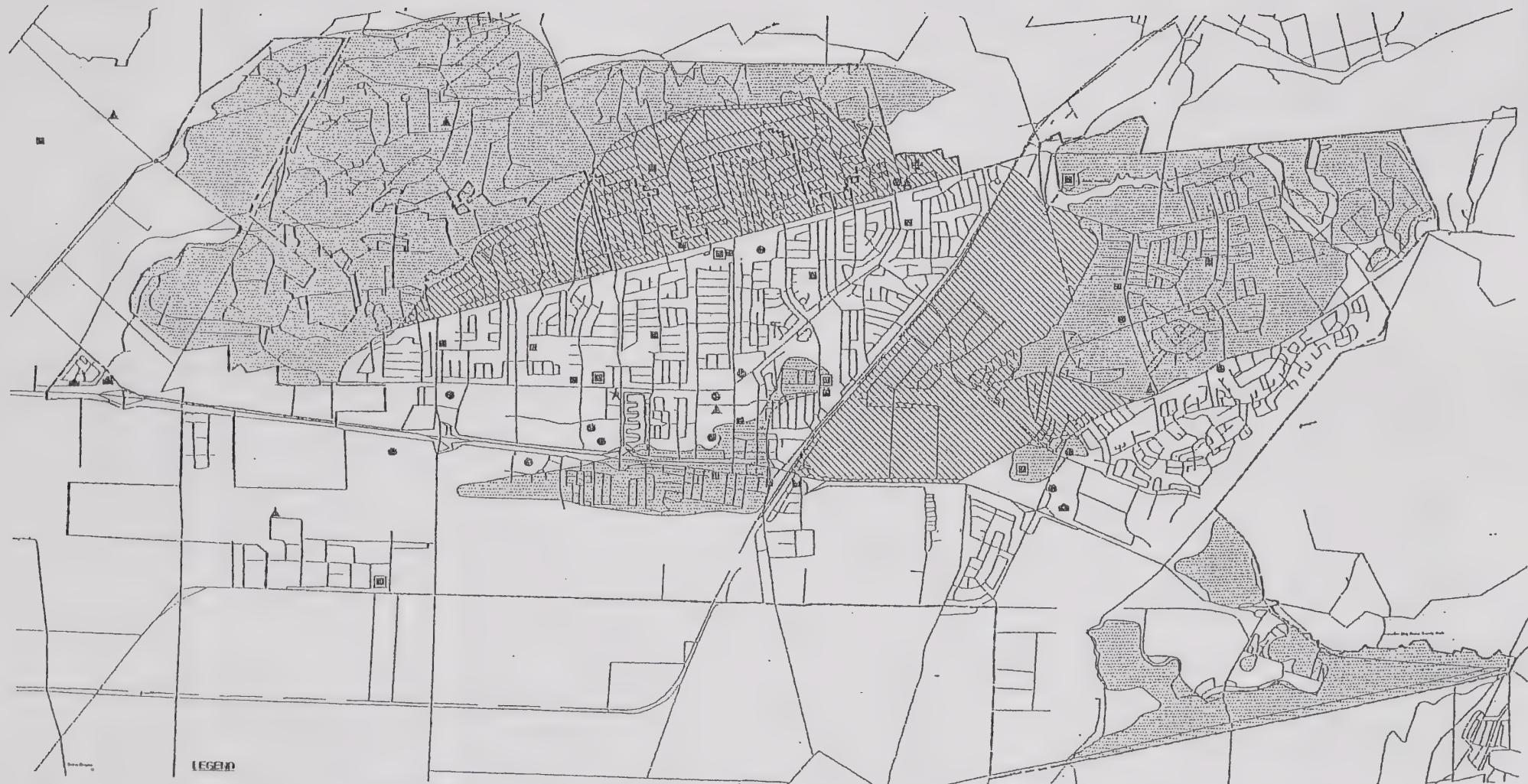
Because much of the Oxnard Plain area of Camarillo and some of

Pleasant Valley have shallow groundwater, those areas typically are assumed to have a high liquefaction potential. However, a recent study of the regional liquefaction potential in the Camarillo area performed using geotechnical data compiled from consultant reports, identified a few specific areas where liquefaction appears unlikely.

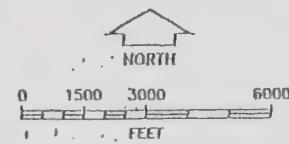
A copy of the liquefaction hazard map prepared as a part of that study is included as Plate V.

As indicated on that liquefaction hazard map, the hillside areas of the city that are underlain by bedrock are considered non-liquefiable. Also the alluvial areas north of Las Posas Road and the alluvial areas north of the 101 Freeway, southeast of Lewis Road, and northwest of Mission Oaks Boulevard are considered non-liquefiable, because groundwater is deep in those areas. Until further data are available, the remainder of the city is presumed to be potentially liquefiable, although the liquefaction potential is not likely to be high in all of those remaining areas. Geotechnical studies in the vicinity of Las Posas Road and the 101 Freeway and in the southern portion of the city south of the 101 Freeway have demonstrated the presence of shallow groundwater and loose granular soils, thus making those areas particularly susceptible to liquefaction hazard.

June 1990  
Project No. 08-42-0751



LIQUEFACTION  
HAZARD MAP  
City of Camarillo



## LOCAL DISCUSSION

### LOCAL INVENTORY OF THE HAZARD

The hazard zones, both the high hazard and the moderate hazard, seem to be restricted mainly to those area south of the Highway 101 Freeway.

There is high hazard in the Del Norte Road area, around the Camarillo Airport, and south of the 101 Freeway. In the area north of the 101 Freeway near Las Posas Road, the liquefaction hazard is probably moderate.

### RESOURCES AFFECTED BY THE HAZARD

The liquefaction hazard appears to have only a very limited effect on the most populated areas of the city of Camarillo. The potential hazard zone extends in a band south and west of the City and up Arroyo Conejo. Most of the buildings of the Camarillo Airport are in the high hazard zone. Also included within the potential hazard zone are the developments along Del Norte Road, in Camarillo Springs, and in Leisure Village. Industrial facilities that are in the potential hazard zone are located on Wood Road north of the Camarillo Airport; west of Lewis Road, south of the 101 Freeway; and east of Pancho Road. General liquefaction could also disrupt agriculture in the hazard zone (See Plate V).

The structures and areas listed above are simply those that are located in the hazard zones on Hazard Plate V. The information used to define the zones was the best available, but does not allow precise delineation of the hazard areas. Also, the boundary lines represent a transition zone that fluctuates seasonally and with changes in water supply. Therefore, those facilities listed are not the only ones that could be affected by the hazard. These, however, should be studied first when alleviation of the hazard is considered.

### HISTORY OF THE HAZARD

Liquefaction damaged several areas in eastern Simi Valley during the 1994 Northridge earthquake, and it is possibly the biggest seismic threat on the Oxnard Plain of Ventura County.

Locally, liquefaction occurred in Calleguas Creek, Mugu Lagoon, and the lower Santa Clara River during the February 21, 1973, Point Mugu earthquake. The effects were mainly the development of minor ephemeral features, such as, shallow cracks and sand boils, but as Morton and Campbell point out in their report (California Geol., Dec. 1973), if the "shaking had been more severe, such effects might well have been widespread and could have resulted in significant agricultural crop losses". Also, the effects on structures could have been significant, if any had been located in those areas.

### DEFINITION OF THE HAZARD ZONE

Large areas of the County have a surface layer of unconsolidated sandy soil thicker than 50 feet, and the entire County is susceptible

to significant earthquake shaking. Therefore, the primary variable factor for liquefaction potential in the County is the depth of the water table. The water level varies, but to be conservative, the highest level is typically considered. This is reasonable in urbanized areas where the water table is usually rising due to a number of factors, including curtailment of pumping, importation of increased amounts of water, reduced evaporation due to paving or impervious cover, heavy irrigation from watering of yards, percolation from septic tanks, and so forth.

Areas that are considered to have a potential liquefaction hazard are alluvial areas that have had groundwater levels within 50 feet of the ground surface at sometime in the last fifty years or since well records have been kept.

The threat posed by this liquefaction hazard varies depending upon the seasonable water level in some areas. The hazard zones designated assume that water levels are at their highest.

## NATURE OF INFORMATION

Groundwater and soil data used to develop the liquefaction hazards map were extracted from the files of the City's Engineering Services Department. Many areas did not have usable soil or groundwater data.

For those areas, a liquefaction potential is assumed to exist until demonstrated otherwise by site-specific geotechnical studies. Alluvial areas are shown on Plate I of the State Division of Mines & Geology report entitled: Geology and Mineral Resources Study of Southern Ventura County (1973).

## MANAGEMENT RESPONSIBILITY

### INVESTIGATION

The Camarillo Engineering Services Department has primary responsibility for reviewing and evaluating geotechnical studies for new developments that investigate the liquefaction hazard. When the Camarillo, Newbury Park, and Santa Paula quadrangle maps come up for review by the California Department of Conservation, Division of Mines and Geology, liquefaction potential maps will be developed. At the present time, the Division of Mines and Geology estimates that it probably will be some time in the year 2000.

### ALLEVIATION

Except for site-specific mitigation or avoidance on new construction, there is little that can feasibly be done to reduce the regional liquefaction hazard. Important or critical structures and large-scale developments can utilize special designs to alleviate the effects of most liquefaction hazards. Land use controls (e.g., avoidance) are the only other methods available to reduce the threat to life and property.

Present Subdivision, Grading, and Building Ordinances require geologic and soils hazards, such as liquefaction, to be considered in the design of land developments and construction of important or

critical structures as well as single-family homes where necessary. Commencing with the 1994 edition, the Uniform Building Code requires assessment of liquefaction potential for new developments.

## FINDINGS

### PROBABILITY OF OCCURRENCE

Liquefaction could occur in the saturated alluvial areas of the city during future large earthquakes. Many experts believe there is a strong possibility of one or more large earthquakes occurring nearby in the next fifty years.

### SEVERITY OF THE HAZARD

The Camarillo Airport and vicinity, which are located in an area of saturated alluvium, might be affected by earthquake-induced liquefaction. Existing important or critical structures not designed against liquefaction might suffer damage.

### RESOURCES AFFECTED

Large industrial facilities in the saturated alluvial areas, such as those on Wood Road, Lewis Road, and Calle Alto, could be affected. The Camarillo Airport area also could be affected.

### NATURE OF INFORMATION

The groundwater levels in alluvial areas were generally estimated by compiling subsurface boring data developed by geotechnical consultants who performed exploration for new developments. The boundaries of the hazard zones are only approximations and are intended to delineate zones where site-specific geotechnical studies for liquefaction potential should be performed. All areas within those zones are unlikely to have a high potential for liquefaction. The estimated effects of liquefaction may vary greatly within a given zone during a given earthquake. Any specific conclusions should be reached on the basis of detailed site-specific geotechnical studies.

### OTHER FINDINGS

Future development plans within the city should be carefully evaluated due to the hazard imposed by the potential of soil liquefaction. Unless structures are adequately designed to resist the potential effects of the hazard, structural damage resulting from the effects of liquefaction could occur to public and private structures and vital utilities within the city in the event of a severe earthquake. In general, the small size of single-story buildings and their inherent flexibility can allow them to tolerate liquefaction effects better than some larger old structures that were not designed for liquefaction mitigation.

### RECOMMENDATIONS

1. Encourage continued performance of regional studies by qualified

Federal and State Agencies such as the U.S. Geological Survey and the State Division of Mines and Geology or private research firms in order to more accurately determine areas of potential soil liquefaction hazards.

2. Encourage and participate in cooperative studies with the above agencies.
3. Evaluate existing critical structures, facilities, and foundation conditions for cases where their susceptibility or resistance to soil liquefaction is unknown and, if necessary locate vital facilities and emergency services outside of the high hazard areas.
4. Continue to adopt the current Uniform Building code and the additional provision of the Zoning Ordinance, Subdivision Ordinance, Building Regulations and the Grading and Hillside Performance Standard or equivalent requirements for all land development.
5. Provide adequate enforcement of the aforementioned requirements by requiring that qualified personnel registered and certified by the State, such as professional engineers and engineering geologists, review each proposal for land development.

## TSUNAMI

### GENERAL DISCUSSION

Tsunamis (pronounced soo-nom-ee) are large ocean waves that are generated by submarine landslides, volcanic eruptions, or earthquakes in or near the ocean basins. The general public commonly refers to those waves as tidal waves. In low-lying areas such as the Oxnard Plain, the hazard zone for tsunamis can extend up to approximately one-mile inland from the Pacific Ocean. Because Camarillo is approximately ten miles from the ocean, they are not considered a significant concern in Camarillo.

## SUBSIDENCE

### GENERAL DISCUSSION

Subsidence, or the sinking of the land surface, is a worldwide problem.

In Ventura County, the main types of subsidence caused by human activity have been identified, in addition to those forms of the hazard that occur naturally. Groundwater withdrawal subsidence, which generally occurs in valley areas underlain by alluvium, is the most extensive, and the impacts most costly. As water is removed from the aquifer, the weight of the overburden is increased on the alluvial structure. If fine-grained silts and clays make up portions of the aquifer, the additional load can squeeze the water out of those layers and into the coarser grained portions of the aquifer. That compaction produces a depression in the land surface.

Current studies focus on six factors: degree of groundwater confinement, thickness of aquifer systems, individual and total thickness of fine-grained beds, compressibility of the fine-grained layers, probable future depth of wells, and probable future decline in groundwater levels. All have a bearing on potential, but the primary causes are substantial for first-time reductions in the water level of a valley-fill alluvium.

Subsidence can and does occur from natural compaction, tectonics, crustal folding, seismic shaking, and liquefaction.

## PHYSICAL PROPERTIES

The surface deformation resulting from oil extraction is a large bowl shape, extending beyond the production area.

In the Wilmington Oil Field, near Long Beach, a drop of 29 feet was recorded in the period 1928 to 1972. A subsidence of similar magnitude occurred in the San Joaquin Valley in 1969 from the extraction of groundwater.

## MEASUREMENT & DETECTION

A series of benchmarks must be established which, over time, show subsiding land and the areas that are subsiding fastest. Core samples would show probable future consolidation, with known fluid withdrawal rates. From that, regulated land use or counter measures to halt the subsidence could be assessed.

In unconfined aquifers, increased recharge through water spreading is possible. Confined aquifers or oil-bearing zones must be repressured by injection wells. Due to the cost, that method has been used only in the Wilmington Oil Field.

## GENERAL EFFECTS OF THE HAZARD

The destruction caused by subsidence is not immediate or violent, except when prompted by seismic shaking. Because most subsidence damage occurs very slowly, it lacks attention. Much money is lost through either premature abandonment or repair.

Most seriously affected are facilities sensitive to slight changes in gradient: wells, canals, sewers, and drains. In a 1970 projection, losses to the year 2000 were estimated to reach about \$26,000,000 for subsidence in California. Oil extraction was responsible for \$100,000,000 damages in the Long Beach area.

Inundation is a potentially serious secondary effect of subsidence in Ventura County. Both the ocean and the Santa Clara River could flood into depressed areas of the Oxnard Plain. The Santa Clara River is building up sediments within its present course while no longer adding deposits to the remainder of the Oxnard Plain. If the old deposition consolidates, a flood could change the river course and thus inundate the lower land. Extraction of oil and/or water could increase the potential for such an occurrence and increase the area affected.

## GENERAL INVENTORY

The Oxnard Plain has been monitored by the U.S. Coast and Geodetic Survey since the 1930s. One large area is subsiding between 0.04 and 0.05 feet per year. A point at Hueneme Road and Highway 1 has dropped 1-1/2 feet in just twenty-one years, and a dozen bench marks have settled a foot in a fifteen- to twenty-year period.

Hazard Plate VI of the Seismic and Safety Element shows three subsidence zones. Those zones are: probable subsidence that is on the order of 0.05 feet/year roughly from Pierpont to Mugu Lagoon south and east to the junction of Highways 1 and 101, and probable subsidence of less than 0.05 feet/year; and the estimated limit of areas presently affected by subsidence, inland from the Oxnard Plain through the Santa Clara River Valley to a point just east of Piru.

## NATURE OF INFORMATION

Definite establishment of the rate and cause of subsidence in Ventura County has not been made. County Public Works information indicates four possible causes: natural consolidation of alluvium, tectonic deformation, water extraction, and oil extraction.

Current data suggests that groundwater has been extracted from the aquifers underlying the Oxnard Plain at a rate that exceeds replenishment by about 44,000 acre feet per year, and the water table has dropped as much as 55 feet below sea level as a result of this continuous overdraft.

As part of a regional effort extending from Santa Barbara to Los Angeles, some 500 to 600 bench marks are being monitored in Ventura County. Readings were taken in 1970 and a second series, five years later, indicated areas of significant change. The County Surveyor is participating in this program which is being conducted by the National Ocean Survey.

Positive determination of the exact limits and rates of subsidence would require special grid of many bench marks (monuments) of special construction and a monitoring program extending over several years.

## MANAGEMENT RESPONSIBILITY

Studies of water withdrawal subsidence have been conducted by the U.S. Geologic Survey and the California Department of Water Resources. State and Federal projects bring surface water to some areas with dropping groundwater tables. Where such replacement is not available, or where it does not make up the difference, control is the responsibility of local water conservation districts. This control is both loose and variable.

Subsidence resulting from oil and gas extraction has been investigated by the U.S. Geologic Survey, California Department of Water Resources, and the California Division of Oil and Gas. The Division of Oil and Gas has a monitoring and regulating program which the "Urban Geology" report ranks as equal to the task.

## FINDINGS

### PROBABILITY OF OCCURRENCE

A subsidence problem does exist; mainly in the Oxnard Plain area of the County. It is probable that it will continue, possibly at an increasing rate. This could occur if extraction of fluids from this area is increased.

### SEVERITY OF THE HAZARD

Measurement to date indicate that a maximum drop on the order of 1.5 feet has occurred over the past 20 years in some areas of the Oxnard Plain. Further surveying is continuing and should better define the magnitude of this problem. Records from other areas of the country and the world indicate many areas experience much more severe subsidence problems than is the case in our county.

### RESOURCES AFFECTED

Property damage due to subsidence can and does occur over a long period of time. Loss of life would probably occur only as a secondary effect of subsidence; wells and utility lines are potentially the most vulnerable to damage.

### NATURE OF INFORMATION

A possibility exists that some potential subsidence damage can be controlled. Such controls, however, must await the definite determination of the cause or causes of subsidence, as well as the rate of this subsidence. Until this information is fully developed, little can be done to plan for or respond to this hazard. The county in 1983 adopted the Water Conservation Management Plan which, among other topics, provided information and guidelines for groundwater management.

## RECOMMENDATIONS

1. That the guideline addressed in the Water Conservation Management Plan continue to be implemented in Camarillo.
2. The water conservation measures continue to be implemented as part of developments in Camarillo.

## EXPANSIVE SOILS

### GENERAL DISCUSSION

Expansive soils (which are identical to soils referred to as having a shrink-swell potential) are those which are generally clayey, expand or swell when wetted, and contract or shrink when dried. Wetting can occur naturally in a number of ways, i.e. absorption from the air, groundwater fluctuations, as well as from other sources, i.e., lawn watering, broken water or sewer lines.

The tremendous force exerted by the expansion of soils is generally not understood by the average person and quite often results in requests for waiver of the soil test as "unnecessary." Such a complacent attitude is unjustified. Typically, expansive soils are located in areas of moderate slope which are, coincidentally, the areas generally most attractive for intense, urban-type uses. The movement of expansive soil may be slow, progressing over a period of years. Commonly, this movement is associated with seasonal or even longer wet/dry cycles.

These soil movements can cause structural damage to houses, pavements and utilities by heaving loss of support under part of a structure, shifting due to the weight of the structure, and shrinking and withdrawal of support.

Damage can range from the impaired functioning of doors and windows through plaster and foundation cracks to total destruction.

In the early 1960's numerous homes in Thousand Oaks' Shadow Oaks subdivision were lost and many more were severely damaged. This area experienced soil expansion, which cracked many two-inch thick slabs.

As the damage started to appear in the new homes of this tract, many of them were vacated. Still others remained occupied but some people stopped making their payments. Many houses were rented, a transient group of people occupied these and the neighborhood generally declined.

Other areas of the county have also experienced problems due to soil expansion, specifically, the Camarillo Heights area. However, here the damage has not been as great because many lessons were learned in the Shadow Oaks case.

Highly expansive soil exists at the east and west ends of the City of Camarillo. The remaining and largest portion of the city is rated in either the moderate or low category. A fairly even division exists between these two zones.

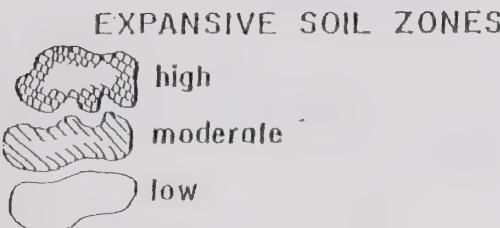
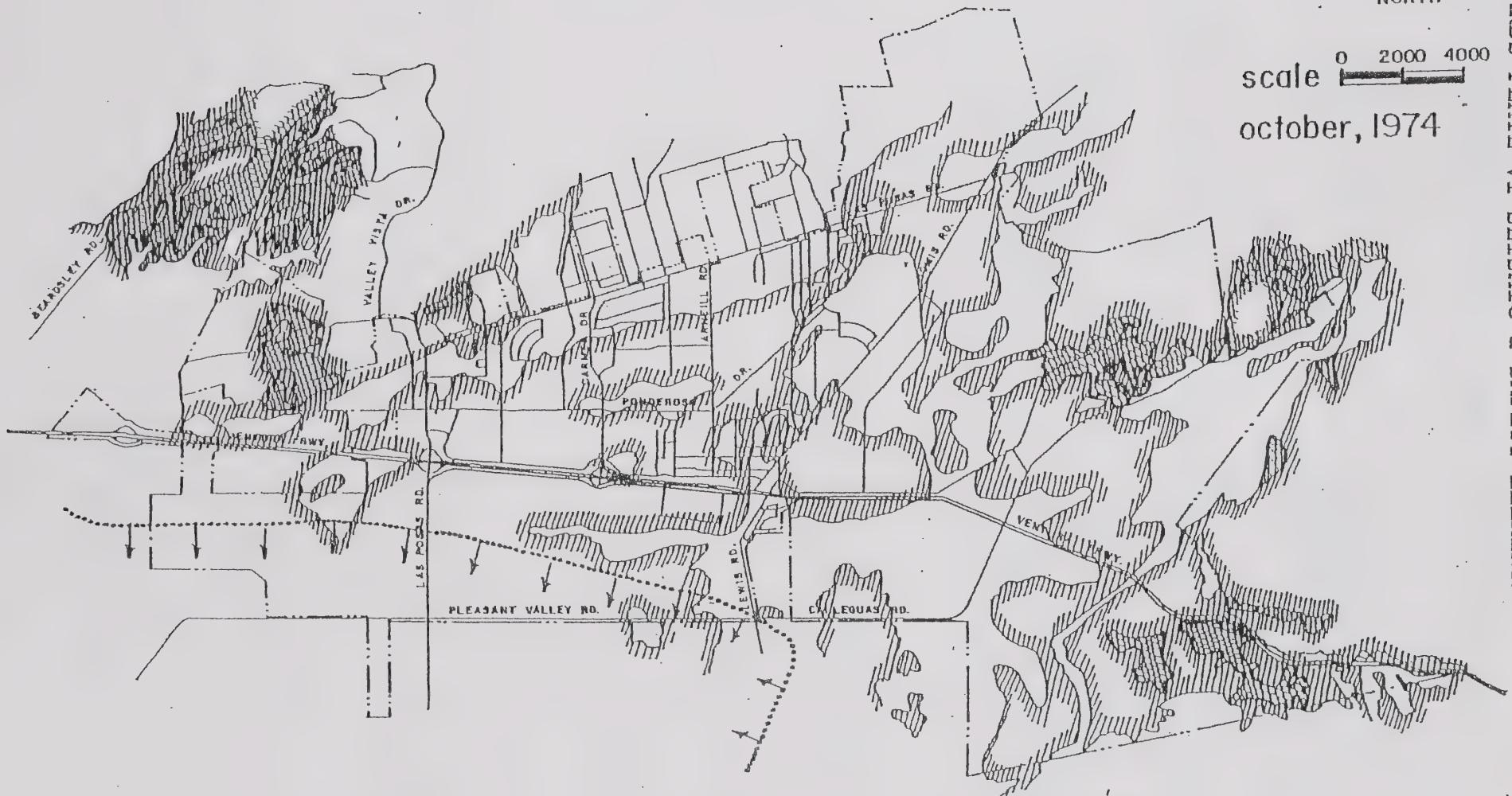
In the past, damage has been recorded in the Camarillo Heights area on the west side of the City. This residential area and another on the east side of the City on Santa Rosa are located in areas of highly expansive soils. The need for careful soil tests and construction countermeasures is particularly pronounced in these areas. That area around the Camarillo Springs Golf Course is also rated as high in terms of expansive soil.

Three expansive soil zones have been mapped and they appear on Hazards Plate VI. Derived from the Soil Conservation Service's 1970 Soil Survey, this map designates high, moderate and low expansive zones. This is a generalized version of individual soils maps. It generally indicates those areas where expansive soils are present. (See Soil Survey in Ventura Area, 1970).

### LOCAL DISCUSSION

A more specific map was prepared for each entity, and the degree of expansiveness may not conform precisely to Plate VI even though both utilize identical categories of expansive soils. The reason for this is that the local maps were taken from the non-generalized maps developed by the Soil Conservation Service and thus display a greater level of detail.

While the general and specific maps are quite useful for locating large areas of potential hazard, it must be stated that they cannot be used in lieu of site inspection when construction is considered.



SOURCE: U.S.D.A. Soil Conservation Service

PROBABLE SUBSIDENCE ZONES

..... estimated limit

SOURCE: Ventura Co. Dept. of  
Public Works

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Experience in the Building and Safety Department indicates that a soils test at the specific site is necessary because this hazard is so localized in nature.

An aspect which must continue to receive special attention is downslope soil creep in hillside areas. As an expansive soils expands and contracts it tends to move downslope in response to gravity. This condition may require flatter slopes, soil removal and special landscaping and irrigation treatment.

Camarillo contracts with a private consulting firm to oversee its building permit and inspection processes. A soils test is required at each site and construction must conform to established standards in areas of expansive soil.

Among the corrective measures which might be employed are various foundation construction techniques, including proper drainage. The degree of expansiveness, as revealed in the expansion test, dictates the type of foundation design. If the expansiveness of a soil exceeds a set limit, then a special engineering design is required for that site and is enforced by the City Engineering Department.

## FINDINGS

Though problems may persist in areas constructed prior to the development of appropriate standards, new construction is being adequately protected from this hazard. Newly-developed construction techniques and the increased knowledge of this hazard could assist in repairing old damage and preventing new.

## RECOMMENDATIONS

That the city continue its program of reviewing developments and its adherence to the standards established by the Building Code and Soil test requirements regarding expansive soils.

## FIRE

### LOCAL DISCUSSION

Ventura County is a very pleasant place. The climate is warm and dry with gentle winter rains and clear summer skies. The hills are green or golden all year long, with brush and oaks at the low elevations and pine forests at the ridge tops. However, these same amenities make it one of the most hazardous fire areas in the country.

The climate is Mediterranean, with rainfall concentrated in the cool winter when there is less evaporation. These winter rains are stored in the ground and in the vegetation. The rains usually stop in May, and there is a drought lasting into November. When a low-pressure trough develops off the coast and high pressure settles over the Great Basin of Nevada and Utah and over the deserts of eastern California and Arizona, the normal westerly wind flow is reversed. Air pours in from the north and east, out of the deserts, down into the coastal basins and valleys. These are the East winds, growing warmer by compression as they descend. They arrive hot, dry, and

charged with static electricity. The extreme dryness desiccates the vegetation already dried by the drought.

The annual grass and wildflowers die in early summer. The dry grass substantially increases the fire hazard. The perennial plants also have special adaptations to resist the drought; the abilities to both shed a portion of their leaves during summer drought and to develop waxy coatings on leaves to cut down evaporation. Unfortunately, these latter two adaptations are major contributors to the extreme flammability of the chaparral.

Wherever these steep slopes are covered with the chaparral vegetation, after a few months of drought, the fire hazard becomes extreme. It should be noted, however, that fire is a normal condition in Southern California. If it were not for the recurrent fires, the chaparral would slowly be replaced by oak woodland, a grassland with scattered live oak trees. The Amerindian populations regularly deliberately lit fires to drive out game; these fires probably were the major contributing cause for the modification of the vegetation from oak woodland to chaparral.

The longer an area goes without burning, the more fuel there is ready to burn. Thus, the more effective we are in preventing fires, the more likely they are to occur.

Brush fires are usually ignited by man, either directly by an arsonist, children playing with matches, individuals careless in smoking, debris burning, fireworks, campfires, and the like; or indirectly through accidents by manmade objects, such as, falling power lines, explosion of heaters or fuel tanks or by sparks from equipment hitting rocks or from engine exhaust. Natural causes, primarily lightning, are now relatively minor causes. The resulting fire can spread very rapidly, at times consuming as much as 3,000 acres an hour. The steep hills help the spread of the fire by allowing it to burn rapidly up hill and frustrating fire suppression attempts. The worst condition exists when fire storms develop, large vortexes that concentrate heat and develop their own winds. Fire storms can jump freeways and the largest fuelbreaks, and are almost impossible to control until weather conditions change.

When weather conditions become severe, all fire fighting personnel are put on alert. When a fire starts, all available personnel are rushed to the scene to keep the fire from developing into a major blaze. If the fire does get out of control and more than the County's own resources are required, mutual aid agreements are in effect with neighboring cities and counties to send additional aid. If the situation becomes worse, State and Federal aid are available.

Fire safety in urbanized areas must be evaluated in different terms than wildland fires: evacuation routes, peak load water supply requirements, minimum road widths, and clearances around structures.

## GENERAL DISCUSSION

### LOCAL INVENTORY OF THE HAZARD

A moderate to extreme brush fire hazard exists in the Camarillo

Hills. The threat is especially great because of the number of houses interspersed with the brush areas. Since much of this area has not burned in this century, there is a great deal of fuel accumulated.

Most of the hillside areas across Calleguas Creek are in the Extreme Hazard Zone (see Hazard Plate VIII). The area between the creek and Santa Rosa Road also has not burned in this century.

Most of the area east of Santa Rosa Road and south of the freeway has been burned at various times in the past and when the brush reaches full maturity, it will probably burn again.

The only way to reduce this hazard is to implement some sort of fuel management program. Pruned and irrigated orchards and most other types of agriculture are excellent fuel breaks. Controlled burning will also reduce the hazard in open areas.

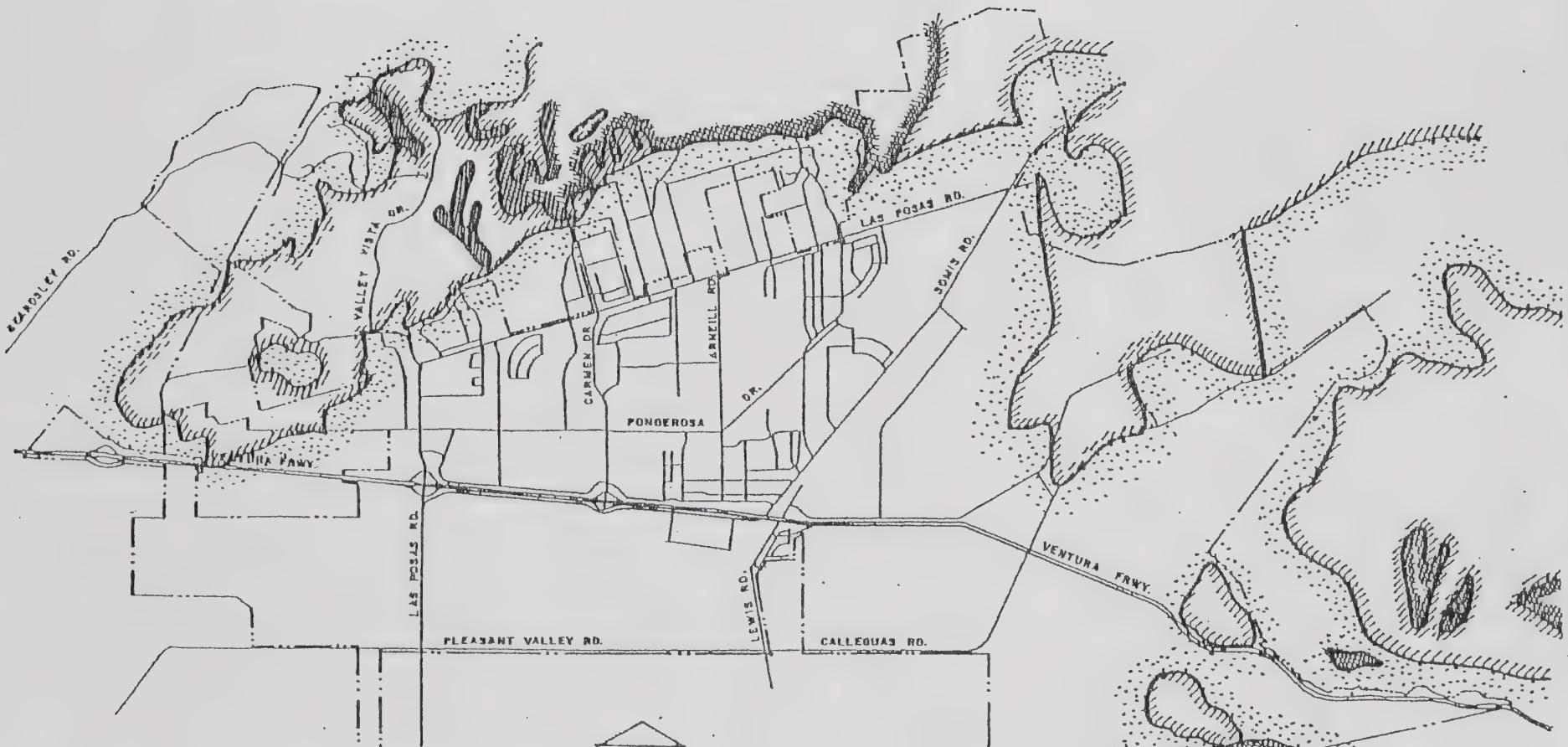
In addition to the wildland fire hazard areas defined on Hazard Plate VIII, the urban areas within the City represent another fire hazard area. Specific areas or structures within the City may be particularly hazardous. These areas have been generally identified by county and City departments (such as the Fire and Building and Safety Departments) and appropriate steps taken to deal as effectively as possible with these situations. However, it is not within the scope of this study to evaluate structural fire hazards.

#### RESOURCES AFFECTED BY THE HAZARD

The only vital services located in the hazard zone within the City are Edison Company power lines. The four main 220KV power lines from Ormond Beach Generating Plant to the Moorpark transmission substations cross the top of Conejo Grade in the City and a number of 66 KV lines also cross through the City.

There are a number of residential areas in or directly adjoining the hazard zone, especially in the Camarillo Hills area, north of downtown. The Camarillo Springs area also abuts the hazard zones near the Conejo Mountains.

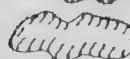
The Upland Road tracts and St. John's Seminary are fairly well protected by their surrounding orchards, as long as the trees are well maintained.



fire hazard



extreme



moderate

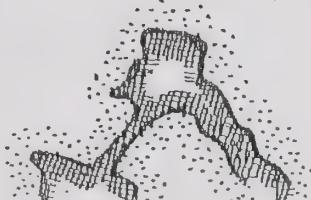


low

scale 0 2000 4000

october 1974

SOURCE: U. S. GEOLOGICAL SURVEY



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## GENERAL EFFECTS OF THE HAZARD

### PRIMARY EFFECTS

In the short run, fire has its most widespread effects on the natural environment. When these vegetation systems burn, the individual plants and their associated animals are destroyed, but the association survives and is actually improved by this natural selection. A good example is the Potrero Fire that burned Point Mugu State Park in 1973. The scene was one of complete desolation following the fire. All the vegetation including the sycamores and oaks were burned, and hundreds of small animals were killed. A month later, deer and birds were abundant and other animals were also on the rise. The burned remains of the brush as root sprouting (with the deer eating the shoots) and most of the burned trees were resprouting leaves. The vegetation and animals were projected to be back to normal in about three years, but with the plants thinned out and the excess animal population culled, to the advantage of both.

Damage to manmade improvement accounts for most of the dollar loss from wildfires (aside from immediate suppression costs). The watershed lost forms the remainder of the total cost. Although developments in the hillside areas have a high value because of the view, they are all too often built in dangerous brush covered areas.

The ridge tops provide more flat areas for house pads, the hillsides and barrancas are in their native vegetative state. Another hazard is that of wood-shake roofs. When a fire burns up the steep hills, cantilevered homes are susceptible to fire on their undersides.

Clearance of brush is more effective when accompanied by regular replanting and maintenance of the canyon area. Requiring that fireproof roofs can limit the spread of fires in new subdivision. Individual fire protection capability, such as gasoline-powered pumps using swimming pool water, reserve water supplies, and roof sprinklers can also reduce damage.

Losses often include sheds, barns, and domestic animals.

The loss of life is higher in structural fires than in wildfires due to the warning time usually available in the latter. Occasionally, homeowners are injured or killed when they do not evacuate their homes (they cannot be forced to leave) but most often civilian deaths are due to either people being trapped without warning or an arsonist who cannot escape the fire he sets.

### SECONDARY EFFECTS

The removal of vegetation by fire leaves the soil bare and open for erosion when the rains begin in the fall and winter. The raindrops hit the surface with undiminished impact, splashing particles of soil which move downhill and are carried off by running water. The fire also destroys roots that hold the soil in place. Under a chaparral cover, compounds accumulate making the soil impermeable to water. If a slope is burned with intense heat, the vaporized compounds condense in a cooler zone just below the surface. Rainfall can penetrate the surface layer and reduce its sheer strength, and carry away the

weakened material as a mudflow.

In January, 1969, mudslides in Glendora destroyed homes and other property valued at some 8 million dollars. Many more millions of dollars of damage were caused by mudflows in Big Sur in 1972.

Buildings destroyed by fires reduce income to local governments from property taxes.

Public utilities are strained by fires, water supplies depleted, power lines are downed and telephone systems disrupted. Flood control facilities may be severely burdened by the increased flow from the denuded hillsides and the resulting debris that washes down. Recreation areas may be closed, or operated at a reduced scale.

Grassland will resprout the following spring, but a chaparral community takes three to five years, and an oak woodland will require five to ten years for a new crop to start. Coniferous timber stands take fifty to a hundred years to reestablish.

## HISTORY OF THE HAZARD

Fires have burned through various areas of the county virtually every year for which records are available, and probably for centuries before that. The largest fire in the county and the state's history burned 219,000 acres, mainly in the Sespe and Matilija Canyon of Los Padres National Forest in 1932.

The last major fire occurrence in the county was the Green Meadow fire in October of 1993. The fire incident was exacerbated by the fact that 14 other fires occurred simultaneously between San Diego and Santa Barbara counties. The fires were collectively known as the Firestorms of 1993.

The Green Meadow fire burned 85,000 acres and destroyed 6 structures at a cost of 3 million dollars. Eight days after the Green Meadow fire began, the Old Topanga incident started. This fire affected 16,516 acres within a 48-mile perimeter. The incident resulted in the loss of life to 3 citizens and destroyed 402 residential units at a cost of \$218 million.

U.S. Geological Survey topographic maps have been used in defining fuel loading and slope. Light fuels occupy the uncolored areas and represent flammable grasses and annual herbs. Medium fuels are "scrub" and include brush and perennials less than six feet having a crown density of 20 percent or more. Heavy fuels are "wood-brushwood" over six feet, having a crown density of 20 percent or more. Slope has an effect similar to wind; and increase in slope produces an increase in the rate of fire spread.

Fire Weather Classification is related to the frequency of critical weather days over a ten-year period. The entire County of Ventura falls in the extreme class with an annual average of more than 9.5 critical fire weather days.

## NATURE OF INFORMATION

No vegetation map that has been completed for the county has had more detail than the USGS Quadrangles (at a scale of 1:24,000, 1 inch = 2,000 feet).

The agricultural and urban areas of the county cannot be considered wildlands for purposes of this classification. Isolated watercourses contain vegetation that is moist year-round and, therefore, has a lower fire hazard. These areas are only included if they are near the wildland areas or contain large amounts of vegetation that is seasonally dry.

Any development in fire hazard zones will be reviewed to meet Federal Firescape criteria when adopted.

## MANAGEMENT RESPONSIBILITY

### INVESTIGATION

The Ventura County Fire Department constantly monitors the fire hazard in the county. They have ongoing programs for investigation and alleviation of hazardous situations.

### PEAK LOAD

### WATER SUPPLY MEASUREMENTS

The water supply for any structure is determined by a complicated formula in the Insurance Services Office Guide for Determination of Required Fire Flow which is enforced by the City Engineering Department. It requires a minimum fire flow of 1,000 gallons per minute in residential areas, 1,250 GPM minimum in commercial areas, and 1,750 GPM minimum in industrial areas. The peak demand rate is the peak domestic flow or the fire flow plus one-half the peak domestic load, whichever is greatest. These flows are minimum requirements only and greater flows may be required by the Fire Chief.

### MINIMUM ROAD WIDTHS

The City of Camarillo Engineering Department has established minimum road widths. Fifty-six feet is the minimum width for a cul-de-sac. A cul-de-sac must have a minimum radius of 56 feet. Fifty-six feet is the minimum road width for a residential minor road. All other roads have larger minimum widths, except private streets with limited number of residential units where a lessor roadway may be acceptable.

### CLEARANCES AROUND STRUCTURES

The best way to protect a structure is to clear away all flammable brush. A minimum clearance of 30 feet is required around all structures, increasing to 60 feet clearance in high grass and low brush areas and up to a 100-foot minimum in any high brush area. Well maintained ornamental plantings do not burn readily.

1. Increase effectiveness of plantings with a high pressure sprinkler system.
2. Remove litter under trees and shrubs; prune out dead wood. Remove dead and dried portions of ground covers and succulents.
3. Leave space between remaining shrubs and trees to help prevent fire spread.
4. Plant lawns, succulent groundcovers, or other low growing plants around all structures, and water regularly. Do not allow continuous tree or brush canopy next to buildings.

Orchards provide a fuel break if the trees are maintained. Eucalyptus windbreaks must be kept very well trimmed or they can circumvent any firebreak provided by an orchard field.

### **FUEL MANAGEMENT SUPPRESSION**

Controlled burning is a process by which the highest hazard areas are burned during the safest times of year. The Air Pollution Control District restricts controlled burning to certain weather conditions; these days are not always the safest in terms of fire control. However, controlled burning seems to be the best fuel management method presently available. Ranchers working with Division of Forestry and University of California Research and Extension Services have developed satisfactory controlled burn procedures. In Ventura County, private burns are under the supervision of the County Fire Department and are encouraged by them.

### **WARNING & EVACUATION**

In a major wildfire, owners and inhabitants in the path of the flames are warned, and evacuation is recommended if the threat is imminent. The responsibility is primarily the Sheriff's Department's, since most fire hazards exist on unincorporated County territory. Evacuation can only be recommended. Evacuation routes are not predetermined, due to the unpredictability of a fire.

### **SUPPRESSION**

The City of Camarillo is included in the Ventura County Fire District which provides fire suppression services. The County has mutual aid and automatic aid agreements with the four city fire departments and the surrounding counties and cities. The State Office of Emergency Service can be called upon for further aid, if necessary, as can Federal agencies, including the Department of Agriculture, Interior, and in extreme cases, Defense.

Private companies and individuals have also assisted, upon request, during fires.

Ventura County has an outstanding Fire Department with a well deserved reputation. They have good equipment including helicopters, except for large air capability for which they have access to air tankers from the State and U.S. Forest Service.

## AFTER THE FIRE

Numerous relief agencies, such as the Red Cross, provide disaster relief to the victims and medical aid and assistance to the fire fighters. In a major disaster, state and even federal relief is possible, including low interest loans to individuals and local governments.

The reseeding of private land after a fire is the responsibility of the California Division of Forestry.

## LAND USE DECISIONS

The Camarillo City Council and the Planning Commission has authority over land uses in fire hazard areas.

Structural encroachments upon hillsides generates a number of problems:

1. Increased direct costs in maintenance of public services and amenities.
2. Increased fire risks in the adjoining highly flammable brush areas (children playing with matches, for example).
3. Reduction in capability of fire suppression forces to accomplish their mission.
  - a. Initial attack time is extended due to road grades and curves.
  - b. Fire spread rate and intensity is increased due to slope factor.
  - c. A potential net loss of strategic locations from which to fight a fire.
  - d. A built-in dilution potential of available suppression forces. (Forces are diverted to protect individual structures rather than concentrate on the key fire locations).
  - e. A potential loss of suitable strategic locations to construct fuel breaks, greenbelts, or other fire prevention measures to protect from fires burning into or out of communities and the adjoining wildlands.

Where these factors cannot be internally mitigated, structural development on slopes is not in the public interest and should be discouraged.

## FINDINGS

### PROBABILITY OCCURRENCE

The Camarillo Hills suffered two fires in 1970 that destroyed some structures. These fires did burn into the city.

The area east of Santa Rosa Road burned in 1958 in a fire that burned to Highway 101. The Conejo Grade area has been burned a number of times, in 1968, 1971, 1975, and again in 1979. The proximity of the highway to the brush probably contributes to the large number of fires in this area.

Those areas, and the area between Calleguas Creek and Santa Rosa Road, could burn again when the conditions are right.

### SEVERITY OF THE HAZARD

The effects of any fire depends upon the fuel, weather conditions, and the resources that could be affected. Since some structures are already located in the hazard zones and the weather is something that cannot be controlled, the fuel available is the critical factor that should be alleviated.

The hazard is severe to these structures in or near the Camarillo Hills, especially those with shake roofs. The City of Camarillo has implemented a brush clearance program on vacant parcels and in rural hillside areas which requires the quarterly removal of vegetation. This assists in reducing the fire hazards in Camarillo.

### RESOURCES AFFECTED

There are some residential communities in the hazard zones and more that are located adjacent to them. The only vital services that are located in the hazard zone are Edison Company power transmission lines.

### NATURE OF INFORMATION

The location of the hazard zones are determined by using U.S. Geological Survey Quadrangle sheets which are not entirely current. These zones were then modified slightly using aerial photos. The boundary lines of the hazard zones, therefore, should be considered approximate. The actual location of brush is the most important criteria.

### OTHER FINDINGS

The fire hazard threat, although it can be somewhat alleviated by fuel management, will exist as long as man interacts with the natural vegetation.

A significant threat exists to buildings unless their ornamental plantings and trees are properly maintained by removing dead limbs, cleaning the ground of leaves and litter, and keeping the plantings well watered.

### RECOMMENDATIONS

#### MANAGEMENT PROGRAMS

1. When feasible, a comprehensive fuel management program should be

instituted to reduce the fire hazard by the Fire District.

2. In any such fuel management program, the particularly hazardous areas identified in the text should be given highest priority.
3. Promote the planting of orchards on the margins of the hazard zone as productive fuel breaks.
4. Encourage brush clearance around structures in fire hazard areas and planting of fire-resistant plant material.
5. Where applicable, take measures to reduce the threat of spreading fires wherever fire hazardous trees are planted as windbreaks in fire hazard areas.
6. Develop a program to reduce the spread of fires by riparian (river bottom) vegetation on the major rivers and creeks.

## DEVELOPMENT CONTROLS

7. Where applicable, all future developments in the hazard zones should include vegetation replacement, fuel breaks or a long-term comprehensive fuel management program as a condition of approval of tentative tract maps.
8. Setbacks for structures in fire hazard zones should be increased to allow for minimum clearance around structures on the same lot that the structure is constructed upon or that arrangements be made for common clearance around a group of structures as in No. 7 above.

## STRUCTURAL DEFICIENCIES

### GENERAL DISCUSSION

The greatest cause of life loss and property damage in an earthquake is the effect the shock has on manmade structures. A major cause is the inability of structures to resist the strong lateral forces created by earthquakes. There is now sufficient knowledge to construct structures which can withstand fairly high lateral forces, and seismic safety can be achieved through careful development and construction practices.

This section focuses on the evaluation and identification of hazardous structural deficiencies, and the development of land use and construction standards to minimize hazards. Local inventories of the hazard are not available and are beyond the scope of this report.

An understanding of the types of structures and their responses to earthquakes is essential. Tables 1 and 2 summarize building types and their response to seismic forces. Briefly, unreinforced masonry, brick and concrete buildings are very susceptible to damage in earthquakes. Parapets, chimneys and other appendages are also hazardous when not properly attached or reinforced. Seismic safety standards in buildings were not required until 1933, after the Long Beach earthquake. Upgrading of the building codes have occurred periodically since then.

Seismic structural safety is two-fold, involving prevention of the hazard and abatement of hazards already existing.

The hazard increases as density of settlement increases, as unsafe structures continue to be used, and as new seismically inadequate structures are built.

In 1960 an earthquake in Agadir, Morocco, calculated at a Richter magnitude between 5.5 and 6.0 shook Agadir's 33,000 inhabitants. After it was over, 12,000 persons had been killed and 12,000 were injured from structural failures. The most prevalent construction material was older masonry which varied from rammed earth (with mortar of mud and sand) to more modern construction of stone or clay tile with mortar ranging from weak mud and sand to good quality sand cement. None of the masonry was reinforced. The second most prevalent types of construction was usually a very poor quality reinforced concrete which had not been designed to resist lateral earthquake forces.

In magnitude, this earthquake compares to the Point Mugu earthquake of February 21, 1973, which measured 5.7 on the Richter scale. This moderate shock caused minor damage in the Point Mugu-Oxnard area.

The 1971 San Fernando earthquake, calculated at a Richter magnitude of 6.6, was a moderate shock near a highly-developed area and a test of the modern city's ability to undergo seismic shock. There were 59 deaths directly attributed to earthquake effects. Had the earthquake centered twenty miles farther south close to the center of population in metropolitan Los Angeles, it would have done much more damage and cause the collapse of many more old buildings. Had it occurred three hours later, there would have been many more occupants in the buildings that did collapse. Had the freeways been crowded, the bridges that collapsed would have caused many more deaths and injuries, and other casualties would have resulted from automobile accidents caused by the sudden disruption of the thoroughfare. Had the earthquake occurred when more people were on downtown streets there would have been many more casualties from falling debris.

Finally, the lower San Fernando Dam had only four feet of freeboard after its partial failure; had it failed completely--or even after emptying was well along--an area inhabited by 80,000 people would have been inundated.

The 1994 Northridge earthquake, with a moment magnitude of 6.7, also shook the San Fernando Valley and surrounding areas. That earthquake was responsible for causing about 61 deaths, 18,500 injuries, and \$13 to \$15 billion in damages. About 14,000 structures in 28 cities were damaged by that earthquake, and about 2,900 of those were sufficiently damaged as to be unsafe for entry. As was the case with the 1971 San Fernando earthquake, if the Northridge event had occurred a few hours later, there would have been many more occupants in the buildings that collapsed. Similarly, if the freeways had been crowded, the bridges that collapsed would have caused many more deaths and injuries, and other casualties would have resulted from automobile accidents.

The 1971 and 1994 earthquakes pointed out major structural deficiencies in the ability of old and new buildings to withstand seismic stress. For example, the San Fernando Veterans Administration Hospital had a number of buildings built between 1925 and 1927 without earthquake resistance measures, which were severely damaged in 1971. Forty-six persons died in the collapse of two such buildings constructed of reinforced concrete frame. The Olive View Medical Center buildings were constructed of reinforced concrete under earthquake-resistant standards. In 1971, it suffered extensive damage, including the collapse of the first floor of the two-story psychiatric building, causing the deaths of three persons. Structural weaknesses appeared in connectors of roofs to masonry or tilt-up walls in commercial or industrial buildings, and inadequate reinforcement of some concrete columns, leading to collapse.

The cause of structural deficiencies may be any one or combination of factors. Construction practices, policies on land use, enforcement of building codes, and rehabilitation programs have not always considered the consequences of seismic activity.

Building Codes are the basis for establishing criteria to meet seismic safety standards. The goal of seismic safety was aptly expressed by the Structural Engineers Association in their publication, "Recommended Lateral Force Requirement and Commentary, 1963," when discussing the purpose of the seismically oriented building codes. The intent is to construct structures, which will:

1. Resist minor earthquakes without damage.
2. Resist moderate earthquakes without structural damage, but with some nonstructural damage.
3. Resist major earthquakes of the intensity of severity of the strongest experienced in California, without collapse, but with some structural, as well as non-structural, damage.

### Table 1

#### TYPES OF BUILDINGS AND PAST PERFORMANCE

Steel Frame Buildings. During the 1971 San Fernando earthquake, no significant structural damage was experienced by any completed earthquake resistive steel frame building in the Los Angeles area. Many did suffer other kinds of damage resulting in a maximum loss of approximately \$200,000 in one case, or about 1% of the value of the building.

Older steel frame non-earthquake buildings performed much more poorly. While none sustained structural damage, many experienced non-structural losses amounting to over 5% of assessed market value.

Concrete Frame Buildings. The experience of the 1971 San Fernando quake showed that earthquake resistive concrete frame buildings performed generally as well as steel frame buildings when located 15 to 25 miles from the epicenter. Of the high-rise buildings which suffered the highest amount of damage, however, many more were of reinforced concrete than steel.

Unreinforced Concrete Block and Hollow Clay Tile Buildings. Older buildings of non-reinforced concrete block laid in sand-lime mortar are extremely vulnerable to earthquake damage. Many of this kind of building suffered slight and moderate damage in San Fernando, and a few experienced severe damage.

Brick Buildings and Reinforced Brick Buildings. Brick and reinforced brick buildings also do very poorly in earthquakes. In the San Fernando quake, pre-1940 brick structures suffered much more severe and moderate damage than any other type.

Reinforced Masonry Buildings. Most of these buildings were built under modern building codes and can be considered generally safe. Their weakness in San Fernando was joint failure, leading occasionally to detachment of roof from walls.

Steel and Sheet Metal Buildings. Metal-sided buildings used for storage and factories perform very well in earthquakes because of their light weight and flexibility.

Wood-Frame Buildings. Wood-frame structures have the best earthquake performance record of all older and smaller buildings. Their light mass accounts for much of their low susceptibility to damage.

Source: Tri-Cities Safety Study, pps. 74-75

## Table 2

### BUILDING COMPONENTS AND PAST PERFORMANCE

Parapets and Chimneys. Probably the greatest loss of life from earthquakes has resulted from the failure of unreinforced unit masonry, particularly unreinforced brick parapets on commercial buildings. Persons on the streets or inside buildings are often injured by such falling masonry. Chimneys can also be a great hazard in houses and small apartments.

Signs and Appendages. Signs, marquees, canopies, and general ornamentation extending out from buildings pose a great potential hazard in earthquakes if not adequately anchored to the building.

Facades. Two kinds of hazards can be caused by building facades. Masonry veneer facades inadequately anchored can be shaken loose by an earthquake, causing danger similar to parapets. On the other hand, open glass facades as on stores, can cause amplified twisting to the building and shattering of glass on the sidewalk.

Ceilings and Hanging Items. Plaster ceilings and ceiling tiles are often shaken loose during an earthquake, as are poorly anchored hanging fixtures, resulting in human injury.

Building Concerns. Heavy furniture, appliances, bookcases, machinery, etc., often are thrown about during earthquake shaking and can cause damage and injury.

Access Routes. Stairwells and doorways are often blocked after earthquakes. Doors and elevators are often inoperative.

## GENERAL EFFECTS OF THE HAZARD

### PRIMARY EFFECTS

The primary effects of the hazard is the loss of life and property. During an earthquake, structures can be expected to undergo the forces of fault displacement or ground-shaking. If a structure is built over faults which rupture, it will inevitably be severely damaged. However, the area affected is localized over the fault. On the other hand, ground shaking effects normally extend over many square miles and structures can be built to resist such forces.

The damage sustained by a structure is dependent on its condition and the intensity of the forces affecting it. Ground motion is excited by the propagation of waves which emanate from the epicenter of an earthquake. During the 1971 San Fernando earthquake, at the Pacoima Dam, the forces exceeded 1.25 g ("g" is the gravitational force) and there was almost continuous accelerations ranging from 0.5g to 0.7g for 12 seconds. Previously, .5g was considered to be the maximum that could be transmitted by an earthquake.

Structures include buildings, utilities, gas, water and sewage lines, bridges, and dams. In the 1971 San Fernando earthquake, it has been estimated that over \$500 million worth of damage occurred and 58 deaths were directly attributed to the earthquake, nearly all from structural failures. Approximately 850 homes, 65 apartment buildings and 574 commercial/industrial buildings were so damaged that they were vacated; some 4,800 homes, 265 apartment buildings, and 1,125 commercial/industrial buildings had appreciable damage, and about 30,000 structures had lesser damage.

The collapse of five new freeway overpasses disrupted transportation arteries. The converter station at the Pacific Intertie of PG&E completed in 1970 suffered \$30 million worth of damage.

The General Telephone Company suffered \$4.5 million in damages and 10 - 20,000 customers lost service for a month. Gas pipelines broke because of ground deformation and 17,000 customers lost service for 4 - 12 days. Water pipes ruptured in over 1,000 places, and the lines were plugged with sand and debris put into the system from damage at the Lower San Fernando Dam.

### SECONDARY EFFECTS

A major secondary effect is the disruption of transportation, communication, and power systems. Structures which house disaster services, fire stations, and hospitals should remain operational after an earthquake. The disruption of transportation arteries could prevent movement of emergency vehicles.

Another effect is the cost of rebuilding. Replacing or rehabilitating a building often costs more than the original construction. Some things can never be replaced. Reinforcement during construction adds only 1% - 2% to the cost. Both government and individuals are burdened with heavy replacement costs.

## GENERAL INVENTORY OF THE HAZARD

### LOCATION

At the present time there is no comprehensive survey or information available on the location of structural deficiencies in Ventura County. Such an inventory would identify the seismic risk that presently exists, through survey and evaluation of public buildings, hospitals, schools, churches, industrial buildings, freeways, dams, utilities, and so forth. From this the need for the abatement of this risk can be evaluated and programs developed.

### LOCAL DISCUSSION

In a general survey of the older portion of Camarillo by the Ventura County Building and Safety Department, a majority of the residences were substandard.

Though "substandard" reflects many deficiencies and not necessarily seismic safety, nearly all of these structures were built before 1933. Wood frame residences are generally safer, but if they were built over 40 years ago and not kept in good condition, a hazard could exist.

### DEFINITION OF THE HAZARD ZONE

No delineation of a hazard zone was possible within the scope of this study. Such a zone could only be developed after a survey identifying and classifying various structures that may create seismic hazard.

The following criteria could be considered as guidelines for determining whether a building is in need of inspection for structural deficiencies. These criteria were presented in the report of the Joint Committee on Seismic Safety to the State Legislature.

1. The building was constructed before 1933, or a later designated date by the proposed State Commission on Seismic Safety.
2. The building lies within a one designated as probably subject to substantial earthquake shaking.
3. The building has load-bearing unreinforced masonry walls using lime and mortar, and wood floors and roof.

## MANAGEMENT RESPONSIBILITY

### **INVESTIGATION**

Structural deficiencies continue to be studied by the Structural Engineers Association of California, who have a statewide Seismology Committee. This committee was first formed in 1957 to resolve differences in existing codes and prepare a single set of recommendations for lateral-force criteria, now in the Uniform Building Code.

In 1969 the State Legislature formed the Joint Committee on Seismic Safety. It has conducted hearings and investigations of past disasters, developed current standards, policies, and program proposals. Their final report, "Meeting the Earthquake Challenge," was published in January, 1974.

Information on structural characteristics of buildings throughout the City should be gathered by the City Planning Department.

### **WARNING & ALLEVIATION**

In 1970, the State Legislature required each city and county to adopt rules and regulations contained in the Uniform Building Codes, 1970, Uniform Plumbing Code, 1970, Uniform Mechanical Code, 1970, and the National Electrical Code, 1971. However, local entities have the ability to adopt these provisions as the situation warrants, and may develop stricter regulations.

The City Council is responsible for the development and implementation of building standards and the alleviation of hazardous situations. These policies are enforced by the Building and Safety Departments.

"Substantial increases in earthquake resistance can be achieved with little increase in cost, if there is proper coordination on seismic safety measures and needs between architects, planners, engineers, and other professionals concerned with the location, design and construction of buildings." (Carl B. Johnson, Consulting Structural Engineer, Los Angeles).

Construction of public schools (excluding state colleges and universities) and of hospitals are regulated by the state. The Department of Transportation is responsible for state highways and freeways. The Department of Water Resources is responsible for the safety of dams in California, except federally owned dams.

### FINDINGS

#### **PROBABILITY OF OCCURRENCE**

A major earthquake in or near Ventura County is inevitable. From the past performance of structures in earthquakes, it can be assumed that a significant hazard does exist in Ventura County; however, there can be no definitive statement, since a local inventory is not available.

The hazard can be reduced through careful land use planning and adequate reinforcement of structures. Maximum earthquake safety can be achieved through formulating engineering standards for new construction, enforcing such standards, and reviewing existing structures and repairing or replacing those found hazardous.

## RECOMMENDATIONS

1. Survey all structures and identify any existing hazard that may be evident by physical criteria appearance.
2. Review and determine if there are any publicly owned structures, hospitals, schools, fire stations, churches, and buildings that could expose a large number of persons to injury in case of structural failures.
3. Identify all structures which meet one of these criteria as in need of further consideration as a possible hazard.
  - a. Building was constructed before 1933, or a later designated date established on an evaluation of the area's history with respect to design and standards and effectiveness of enforcement.
  - b. Building lies within a zone designated as probably subject to substantial shaking.
  - c. Buildings constructed with reinforced masonry and brick walls and wood floors and roofs.

### Elimination and prevention of the hazard:

4. Eliminate the most hazardous structures through the removal or reinforcement of the structure against seismic forces. Priorities should be decided based on these criteria (not in any order of priority):
  - a. Those facilities whose continued performance is critical immediately after an earthquake.
  - b. Those structures whose failure would cause significant numbers of injuries and perhaps substantial loss of life.
  - c. Those structures whose failure would result in an unacceptable level of potential economic loss to the community.
5. Continue to implement land use policies which would restrict certain structures from being built in ground-shaking hazard zones.
6. Continue to implement building codes which reflect the most recent findings in the field of structural seismic safety.
7. Continue to support adequate enforcement of the building codes by employing a technically qualified staff.

8. Continue to support any means to ensure the general availability of earthquake insurance.

## EVACUATION ROUTES

Evacuation routes in Camarillo are dependent upon the event and need for evacuation. During a breach of the Bard Reservoir, the only required evacuation route would be the movement onto high ground out of the flood plain, which is generally north of Ponderosa, westerly of Ponderosa and Las Posas and easterly of Calleguas Creek northerly of Ventura Freeway. In the event of a major chemical spill or other significant disaster, the city would be evacuated using Highway 101 for east and westerly traffic or Lewis Road for evacuating the residents to the north or south.

The City of Camarillo has formed a disaster preparedness team composed of the fire, police, city employees, and volunteer groups which will come together in the event of a community disaster, be it an earthquake, dam break, plane crash, or other emergency. This team conducts regular disaster preparedness drills and would coordinate the evacuation of areas of Camarillo.

## HAZARDOUS MATERIALS

The City of Camarillo, in conjunction with the County of Ventura, has adopted a hazardous waste/materials management plan which addresses the storage, disposal and use of hazardous materials. The county plan is presently being reviewed by the State Department of Health Services. Once the county receives state approval, Camarillo will have 180 days to either adopt a hazardous waste/materials management plan consistent with the approved county plan or incorporate by reference the applicable portions of the county plan into the city General Plan. As part of either action, the city will expand the Zoning Ordinance and Industrial Performance Standards to address the storage, use, and disposal of hazardous materials. The implementation of this plan will also result in the use of more stringent planning and siting criteria in the review of land use proposals.

Hazardous materials in context of the Plan are found throughout the city and encompass the paints and cleaning solvents commonly found in the home along with the chemicals commonly used in the commercial and industrial areas of the city. No area in Camarillo is exempt from hazardous materials and procedures need to be established for the storage and disposal of these materials. The county plan outlines a countywide program for the management of the use, storage, and disposal of hazardous materials which can be used in developing an expanded program for Camarillo.

Hazardous Material means a substance or substances which because of quantity or concentration, or physical, chemical, or infectious characteristic may either a) cause or significantly contribute to an increase in mortality or an increase in serious illness; or b) pose a substantial present or potential hazard to human beings or the environment. The County Hazardous Waste/Materials Management Plan includes a strategy for the management of these materials countywide.

## RECOMMENDATIONS

1. Coordinate with the county in the implementation of the Hazardous Waste/Materials Management Plan to ensure that the plan conforms to state law and includes the latest information regarding the storage, use, and disposal of hazardous materials.
2. Amend the Zoning Ordinance and Industrial Performance Standards to address the storage, use, and disposal of hazardous materials.
3. Review and revise as appropriate the Hazardous Waste/Materials Plan at three-year intervals in accordance with state law and to ensure that appropriate changes in technology are addressed.
4. Establish siting criteria for industrial uses which utilize highly toxic hazardous materials.

## **CORRELATION BETWEEN SAFETY ELEMENT AND LAND USE ELEMENT**

The Safety Element has been designed to address the public safety needs projected by the land uses as illustrated on the Land Use Element of the General Plan. It is appropriate to examine each application when it is submitted for development to ensure that they do not subject people or property to unsafe situations as described in the Safety Element. Developers are responsible for providing studies regarding the potential unsafe situations and whatever improvements are necessary to correct the problem. During the evaluation of each land use in respect to the Safety Element, the city shall take into consideration the actual design of the project in regard to geotechnical studies, flood hazards, public safety, evacuation, and the use, storage, and disposal of hazardous materials.



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When considering a land use change for a particular area under the Land Use Element of the General Plan, it is also necessary to reassess the Safety Element to make sure that the various classifications or intensities of development are compatible with the geotechnical studies, flood hazards, public safety, evacuation routes, and the use, storage, and disposal of hazardous materials. In addition, the residual impact of that project on existing facilities under the Safety Element of the city should be examined. To assist in implementing the correlation between the Land Use Element and the Safety Element, the following policies shall be implemented and used in evaluating each project:

1. Development applications shall be reviewed to ensure that appropriate information regarding geology, flooding, and hazardous materials has been submitted.
2. Development projects shall incorporate appropriate setbacks from faults.
3. Development projects shall be free of flood hazard.
4. Development projects shall not create problems associated with the storage, use, or disposal of hazardous materials.

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